Construction Site Erosion and Sediment Control Certification Course

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Section 1

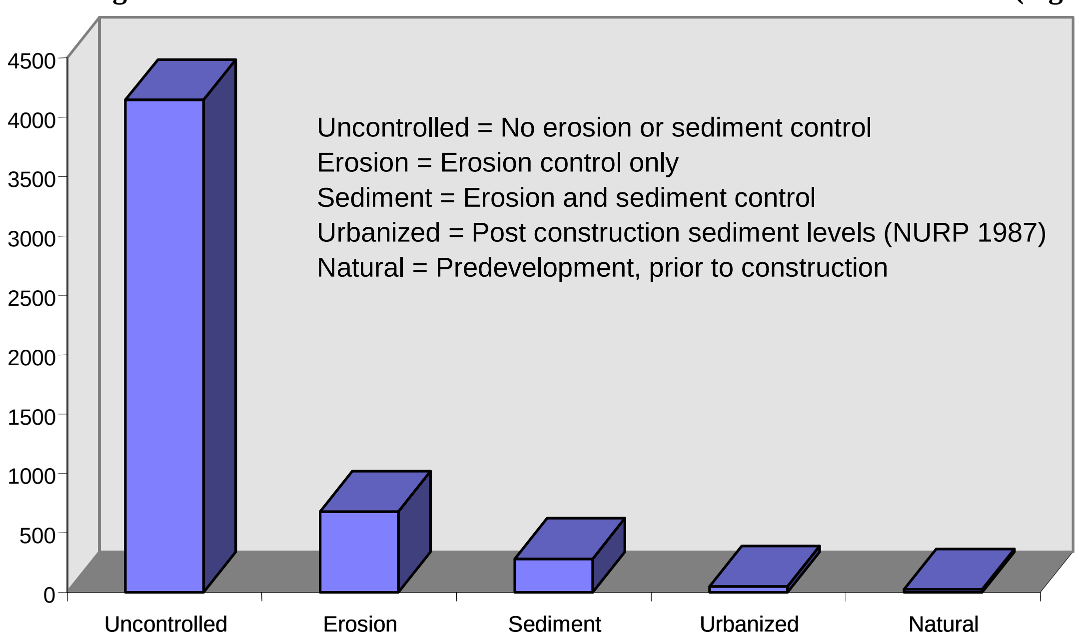
1.1 Introduction

This document is to be used primarily as the training manual for the Construction Site Erosion and Sediment Control Certification course. It should be used as a resource, in addition to the *Highway Runoff Manual*, *Design Manual*, and *Construction Manual Standard Plans*, and *2004 Standard Specifications for Road, Bridge and Municipal Construction*, by anyone designing, implementing, and inspecting Temporary Erosion & Sediment Control (TESC) plans. Material presented in this manual is also available at the WSDOT Erosion Control Program website located at: http://www.wsdot.wa.gov/eesc/environmental/programs/hazwqec/wqec.htm. The website provides links to all products, guidance documents, websites, and other educational resources presented in this course.

1.2 Laws and Regulations

Construction projects often expose large areas of soil that significantly increase the potential for soil erosion. Unprotected construction sites may have erosion rates exceeding 1,000 times the pre-construction rate (Figure 1.2). Uncontrolled soil erosion can damage construction projects and the surrounding environment, especially if eroded sediments enter surface waters. Partly in response to this fact, there are laws that protect water quality that Washington State Department of Transportation (WSDOT) must follow.

Figure 1.2 Construction Site Runoff – Median Sediment Concentration (mg/l)



Source: Performance of current Sediment Control Measures at Maryland Construction Sites, Virginia Erosion and Sediment Control Handbook.

1.2.1 The Clean Water Act

Water pollution is regulated under the Federal Water Pollution Control Act of 1972, known as the Clean Water Act (CWA). The CWA established effluent discharge limitations and receiving water quality standards under United States Environmental Protection Agency regulation (EPA). Enforcement of the CWA has been delegated to the Washington State Department of Ecology.

Until the mid-1980s, emphasis was on control of point source pollution, typically outfalls from industrial factories and municipal sewage treatment plants. The CWA was amended in 1987 to include non-point sources of pollution. These sources originate from diffuse and diverse activities in a watershed that enter a water body through non-discernible, unconfined and indistinct conveyances. Stormwater pollution generally originates as non-point pollution, but is typically collected, conveyed and discharged as a point source.

1.2.2 National Pollutant Discharge Elimination System (NPDES) Permit

NPDES permits are currently required on WSDOT projects that involve disturbance of 5 acres or more. As a result the NPDES permit (commonly referred to as General Stormwater Permit) is the most commonly encountered construction permit on WSDOT construction projects. NPDES permits require, among other things, TESC and SPCC plans.

The Washington State Department of Ecology has published numerous guidance documents relating to NPDES and other construction-related permits including the *Guidance Document for Applying for Ecology's General Permit to Discharge Stormwater Associated with Construction Activity*, and *Working in the Water*. These and other publications can be found on the Ecology website at:
http://www.ecy.wa.gov/programs/wq/stormwater/construction/ - reissue

1.2.3 Endangered Species Act

The Endangered Species Act of 1973, as amended, was adopted to prevent the extinction of animals and plants. The ESA protects endangered species by prohibiting "the take of listed species without special permit" where:

- Take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect or the intent to engage in such activities. Harm includes indirect harm to listed species by harming the habitat.

Several stocks of salmon and bull trout have been added to the list of species protected by the ESA. These listed species inhabit waters in all regions of the state. Accordingly, protection of endangered fish species is considered on nearly all projects.

Adequate erosion and sediment control is essential for complying with the ESA where construction runoff enters state waters inhabited by protected species. Sites that fail to comply with erosion and sediment control requirements may violate the ESA by taking listed species through:

- Directly killing or harming listed fish: Clogging or damaging gills and, smothering eggs with sediment, or
- Indirectly harming fish by modifying or degrading their habitat to the point that it significantly impairs essential behavior patterns, including breeding (i.e., clogging spawning gravel), feeding (i.e., reducing light penetration and food supply), or sheltering (i.e., filling pools with sediment).

1.2.4 Impacts of Erosion & Sedimentation

Fish spawn in gravel to protect their eggs from predators and because their eggs require clean, cold water that provides oxygen and removes waste. This is disrupted when soil erodes and sediment is deposited in the gravel. As a result, the eggs often suffocate and the gravel beds become unsuitable for future egg incubation.

Also, turbid water reduces the food supply for fish and their ability to find food. Many of the invertebrates that fish eat are filter-feeders, and their numbers tend to decline if their filter feeding mechanisms become clogged with suspended sediment. In addition, suspended sediment can clog and be very abrasive to fish gills.

Another consequence of turbid water involves reduced light penetration to the bottom of the stream, which creates a reduction in algae and plant growth. A reduction in plant growth, which is the base of the food chain, means a reduced food supply for fish.

1.3 WSDOT Erosion Control Program

1.3.1 Program Components

In response to the potential for sediment discharged from construction sites and federal/state regulations, WSDOT has developed an overall approach to protect water quality while completing its mission of building and maintaining a quality transportation system. The Erosion Control Program (ECP) does this by applying the standards of an Environmental Management System to proactively plan, implement, and monitor Temporary Erosion and Sediment Control (TESC) activities. The ECP maintains effectiveness through regular review and update of existing erosion control policies, procedures, guidance documents, and training curriculum. Changes are based on solid data gathered by a number of compliance assurance activities.

Guidance Materials

Maintaining guidance documents is essential to high quality erosion control planning and effective implementation. Success is based on a strong partnership with Regional Environmental Offices, Headquarters Design and Construction Offices, individual Project Engineer Offices, private-sector training partners, and contractors.

Compliance Assurance

An Environmental Management System ensures efficiency and allows accountability to be demonstrated to resource agencies and the public. It relies heavily on compliance assurance activities in its continuous evolution of effectiveness. The two primary activities used are the annual fall assessment and standardized water quality monitoring protocols.

Training

Training is the most effective tool for conveying erosion control policy and procedure updates since there is direct contact with individuals responsible for implementing the changes. The ECP has three partners to provide training to the contractors. Between WSDOT and its' partners, an average of 800 people take this course annually.

Technical Assistance

The Erosion Control Program provides technical assistance to WSDOT staff preparing TESC plans or implementing them in the field or those monitoring water quality.

1.3.2 Highway Runoff Manual Minimum Requirements

The *Highway Runoff Manual* contains nine minimum requirements that WSDOT employs to protect surface waters. Erosion and sediment control is largely dealt with in Minimum Requirement 1, but it is relevant to all of the minimum requirements.

Minimum Requirement 1 – Stormwater Planning

All projects that meet the thresholds in Section 2-2 require Stormwater Planning. The two main Stormwater Planning components are Construction Stormwater Pollution Prevention Planning and Permanent Stormwater Control Planning. With WSDOT's specialization of disciplines, size of projects, and programmatic approach to contracting and maintenance, a combination of documents are used to meet Stormwater Planning requirements. Multiple documents are also required because stormwater issues are thoroughly integrated into WSDOT's design, construction and maintenance programs. Construction Stormwater Pollution Prevention Planning components consist of Spill Prevention, Control, and Countermeasures (SPCC) plans and Temporary Erosion and Sediment Control (TESC) plans. Permanent stormwater control planning components include Hydraulics Reports and the Maintenance Manual.

Minimum Requirement 2 - Construction Stormwater Pollution Prevention

All projects must address Construction Stormwater Pollution Prevention, of which the main components are:

- Temporary Erosion and Sediment Control (TESC) plans.
- Spill Prevention Control and Countermeasures (SPCC) plans.

Projects that disturb 7,000 square feet of soil or more must prepare a TESC plan in addition to a SPCC plan. The TESC plan must address the 12 elements described in Section 2.3 of this manual.

SPCC plans are prepared by the contractor and are required on all WSDOT projects regardless of size or activities. The contents of the SPCC plan are described in Section 1.3.4 below.

Minimum Requirement 3 - Source Control of Pollutants

All known and reasonable source control BMPs must be applied to all projects. Source control BMPs must be selected, designed, and maintained in accordance with the Highway Runoff Manual.

Minimum Requirement 4 – Maintaining The Natural Drainage System

Natural drainage patterns shall be maintained and discharges from the site shall occur at natural locations.

Minimum Requirement 5 - Runoff Treatment

Projects that meet certain thresholds described in section 2-2 of the HRM must provide permanent runoff treatment using physical, biological, and chemical methods.

Minimum Requirement 6 - Flow Control

Unless an exemption applies, the project must provide flow control of stormwater runoff from the newly created impervious surface. This requirement applies to projects that discharge stormwater directly, or indirectly through a conveyance system, into a receiving water body.

Minimum Requirement 7 - Wetland Protection

Discharges to wetlands must maintain the hydrologic conditions, hydrophytic (wetland) vegetation, and substrate characteristics necessary to support existing and designated uses. The requirements for Minimum Requirement 5, Runoff Treatment, must also be met for stormwater discharges into a wetland.

Minimum Requirement 8 - Incorporating Watershed-Based/Basin Planning and Local Requirements Into Stormwater Management

Many regions of Washington have basin plans in place that may subject projects to equivalent or more stringent minimum requirements for erosion control, source control, treatment, operation and maintenance, and alternative requirements for flow control and wetlands hydrologic control.

Minimum Requirement 9 - Operation and Maintenance

An operation and maintenance manual that is consistent with the guidance in Chapter 5 of the HRM must be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for such maintenance and operation must be identified. A log of maintenance activities must be kept and be available for inspection by the local government.

1.3.3 Temporary Erosion and Sediment Control Plan

A TESC plan must be prepared if a construction project adds or replaces (removal of existing road surface down to base course) more than 2,000 square feet of impervious surface or disturbs 7,000 square feet or more of soil. Projects that disturb less than 7,000 square feet of soil must address erosion control, but a stand-alone TESC plan is optional.

The TESC plan establishes when, where, and how specific BMPs will be implemented to prevent erosion and the transport of sediments from a site during construction. All TESC plans must address the 12 elements described in Section 2.3 of this document and in the *Highway Runoff Manual*. The elements include:

#1: Mark Clearing Limits
#2: Establish Construction Access
#3: Control Flow Rates
#4: Install Sediment Controls
#5: Stabilize Soils
#6: Protect Slopes
#7: Protect Drain Inlets
#8: Stabilize Channels and Outlets
#9: Control Pollutants
#10: Control Dewatering
#11: Maintain BMPs
#12: Manage the Project

1.3.4 Spill Prevention Control and Countermeasures (SPCC) Plan

All WSDOT projects require the contractor to prepare a SPCC plan. It describes the BMPs that will be employed to prevent the contamination of a site from all forms of pollution other than sediment. The contents of the SPCC plan include:

- Site information and project description.
- Spill prevention and containment.
- Spill response.
- Material and equipment requirements.
- Reporting information.
- Program management.
- Plans to contain preexisting contamination (if necessary).

Numerous courses are offered to WSDOT and contractor personnel in SPCC planning and inspection. Information on these courses is provided in Section 4 of this manual.

1.3.5 Erosion and Sediment Control Lead

Erosion and Sediment Control (ESC) Leads are required on all WSDOT projects involving earthwork. The qualifications and responsibilities of the ESC Lead are described in section 8-01.3(1)B of the *Standard Specifications*.

Page 8-2 2004 Standard Specifications
8-01.3(1)B Erosion and Sediment Control (ESC) Lead

The Contractor shall identify the ESC lead at the preconstruction discussions. The ESC Lead shall have, for the life of the contract, a current Certificate of Training in Construction Site Erosion and Sediment Control from a course approved by WSDOT's Statewide Erosion Control Coordinator. The ESC Lead shall implement and update the Temporary Erosion and Sediment Control (TESC) plan. Implementation shall include, but is not limited to:

1. Installing, maintaining, inspecting and repairing all temporary erosion and sediment control Best Management Practices (BMPs) included in the TESC plan to assure continued performance of their intended function. All on-site erosion and sediment control measures shall be inspected at least once every five working days, each working day during a runoff-producing rain event, and within 24 hours after a runoff-producing rain event. Damaged or inadequate TESC measures shall be corrected immediately. A TESC Inspection Report shall be prepared for each inspection and shall be included in the TESC file. A copy of each report shall be provided to the Engineer. The inspection report shall include, but not be limited to:

a. When, where and how BMPs were installed, maintained, modified, and removed;
b. Repairs needed and repairs made;
c. Observations of BMP effectiveness and proper placement;
d. Recommendations for improving performance of BMPs.

2. Preparing, maintaining, and updating a TESC file on site that includes, but is not limited to:

a. TESC Inspection Reports.
b. Stormwater site plan.
c. Temporary Erosion and Sediment Control (TESC) Plan.
d. National Pollutant Discharge Elimination System construction permit (Notice of Intent).
e. Other applicable permits.

Upon request, the file shall be provided to the Engineer for review.

Thousands of people have completed the course to date and are making significant improvements to the overall quality of erosion control planning and implementation on WSDOT projects. Re-certification is required every three years to keep training consistent with changing regulations and technologies.

1.3.6 Water Quality Sampling and Reporting Procedures

The following procedures have been developed as minimum requirements for use with WSDOT projects involving in-water work and erosion control. These procedures have been developed to document compliance with state of Washington surface water quality standards (chapter 173-201A WAC), other local, state, and federal permit conditions, and conditions of the *Implementing Agreement Between the Washington State Department of Ecology and the Washington State Department of Transportation Regarding Compliance with the State of Washington Surface Water Quality Standards (*Implementing Agreement). These procedures are also used to evaluate the effectiveness of best management practices (BMPs). Projects that require additional permit conditions can incorporate additional sampling parameters into these protocols.

Standard Sampling Equipment

All regions use the following water quality sampling equipment. This equipment was selected for the purpose of legal compliance and should be maintained for the purposes of documentation of project conditions and legal records of WSDOT construction activities.

Turbidity	Hach Model 2100 p portable turbidimeter with sampling bottles

pH and temperature	Hach Model SensION portable pH meter
Water flow meter	MJP Geopacks ZMFP 51 or equivalent
Water sampling rod & cup	(12-foot extendable)
Rain gauge	Tru-Check brand or equivalent installed on-site
Field notebook	For recording data/observations

Presampling Procedures

Prior to water quality sampling in the field, the responsible WSDOT personnel perform the following procedures:

a. **Review Important Project Information and Assess Risk**
Review project maps, project definition, and schedule to understand when and where construction activities have the greatest potential to impact specific water quality parameters. Standard activities and project conditions that require sampling are as follows.

1) **In-water work.** Such projects require work below the ordinary high water mark of state water bodies.

2) **High-risk erosion control projects.** Such projects involve more than 5 acres of soil disturbance, discharge to state waters within 300 feet of the project, and meet at least three of the four following characteristics:

    a) More than 50 percent of the site consists of soils in Hydrologic groups C and D.
    b) The project involves wet-season work or lasts more than one year.
    c) Cut/fill slopes exceed more than 50 feet in length.
    d) There are active seeps or shallow ground water on the project site.

3) **Moderate-risk erosion control projects.** Earthwork projects that discharge concentrated flows to state water bodies.

4) **Tidally-influenced erosion control projects.** For projects either within tidal waters or that discharge to them, it is recommended to call WSDOT for guidance.

b. **Verify Classification and Water Quality Standards**
Verify the classification and water quality standards for potentially impacted water bodies according to the state of Washington surface water quality standards (chapter 173-201A WAC). Read the local, state, or federal permit(s) in the construction document/contract to ensure a good understanding of any additional water quality requirements of the project.

c. **Establish Sampling Locations**
Establish sampling locations to determine background, outfall, and downstream water quality conditions. Sites with multiple outfalls or stream crossings may

require numerous sampling stations. Locate sampling points according to the following criteria:

1) **Background condition.** Locate background sampling locations where water bodies enter the right-of-way, or 100 feet upstream from the outfall, whichever is closer.
2) **Discharge water quality**. Locate sampling point at the outfall to the receiving water.

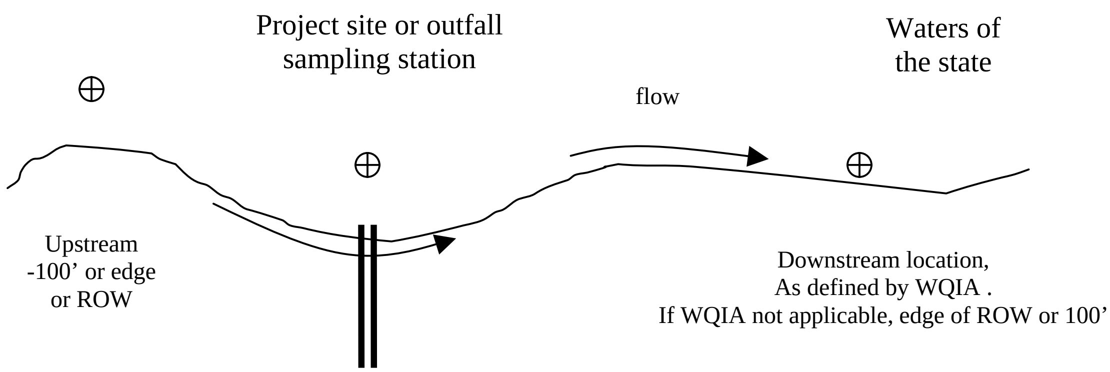
3) **Downstream impacts.** For projects involving in-water work where a mixing zone is allowed, use the flow meter to determine downstream sampling distances as defined in the Implementing Agreement.

4) **All other projects.** Sample where the water body leaves the right-of-way, or 100 feet from the outfall, whichever is closer.

d. **Create Base/Site Map**

Develop a relatively small-scale map depicting the project, sampling locations, and major water, land, and road characteristics. Keep the map in the field notebook so that other staff can understand the locations and access the sampling stations.

Figure 1.3.6.1   General Layout of Typical Water Quality Station Locations.



e. **Establish Sampling Schedule**

Establish a sampling schedule to ensure that monitoring is conducted during the high-risk activities and construction periods. Follow the minimum sampling schedules for the following project types.

1) **In-water work.** Sample daily during in-water work activities.

2) **High-risk erosion control projects.** Sample daily during all storm events that cause discharges to regulated water bodies and all other intentional discharges to surface waters, including (but not limited to) draining of ponds,

vaults, or footings; flushing of water lines, etc. During temporary suspension of construction, monitoring also is suspended if samples from three consecutive storm events meet water quality standards.

3) **Moderate-risk erosion control projects.** Sample daily during storm events that exceed 0.5 inches of rainfall within 24 hours, while the project is active.

f. **Contingency Sampling**

Variations from standard procedures may be required depending on exact field conditions and other project considerations. Establish procedures to adapt to unanticipated events such as severe storms, schedule adjustments, modified construction techniques, etc. Clearly record any modifications to the procedures in the field notebook. Following any water quality violation, additional sampling is needed to verify when site runoff has returned to compliance.

g. **Equipment Calibration**

Calibrate equipment according to manufacturers' recommendations and according to their specified schedule. Calibration frequency must follow the manufacturers' recommendations at a minimum for data to be legally defensible. Additional calibrations should be performed immediately if data appears suspect.

h. **Field Equipment Checklist**

- Sampling cup/rod or hip waders
- Turbidity equipment (check batteries and sampling supplies)
- pH equipment (check batteries and sampling supplies)
- De-ionized water for rinsing equipment (distilled)
- Water flow meter (in-water work only)
- Long survey stakes, hammer, and marking pen (initial set up only)
- Rain gauge
- DOT-approved safety vest and hardhat
- Camera
- Field notebook for recording sampling data and field conditions
- Cellular phone and contact phone numbers.
-

Sampling Station Setup

Mark all sampling station locations with clearly labeled survey stakes.
Photograph each sampling station for future reference and reporting. Picture(s) should show a good relationship of the project, sampling station, and surrounding environment. If sampling outside WSDOT right of way, survey stake locations should be within WSDOT right of way with direction and distance labels to the exact sampling point locations. Record the exact sampling point location in field notebook.

Preconstruction Baseline Sampling

Prior to beginning compliance monitoring, baseline water sampling is required to establish background water quality characteristics above and below the site. It is important to show the existing water quality conditions both above and below the site prior to construction, as natural stream bank erosion or preexisting stormwater outfalls from adjacent properties may cause differences between proposed monitoring points. Whenever possible, baseline monitoring should be performed during a rainstorm.

Sampling Procedures

The following sampling procedures must be used:

- Sampling begins at the most downstream station first and works upstream to the uppermost station, to avoid contamination.
- Testing of samples should occur at the designated sampling station whenever possible.
- Collect samples from as close to the center of the water body as practical. Use the sampling rod if necessary.
- Fill the sampling bottle (downstream) at least once prior to collecting the sample, to remove possible contaminants. Shake the sample prior to turbidity testing.
- Sampling for pH should occur prior to turbidity testing, as temperature affects pH.
- Follow the manufacturers' recommendations for equipment operations.

Sampling Information

The following information is recorded in the field notebook for each sampling event on the Daily Data Record Form:(samples of the Daily Data Record Form, Summary Report Form, and Monitoring Report Form can be found at : http://www.wsdot.wa.gov/environment/eao/wqec/wqec_water.htm.)

- The date, time, and location of the sample.
- Project name and contract number.
- Name(s) of personnel who collected the sample.
- Field conditions (weather, temperature, pertinent construction activities, any prior disturbance of the water body, etc.).
- The testing results for measured parameters.
- Date and time of the last calibration of sampling equipment.
- Notes summarizing critical activities, unusual conditions, corrective actions, whether or not photographs were taken as supporting documentation, etc.

Samples of the Daily Data Record Form, Summary Report Form, and Monitoring Report Form can be found at http://www.wsdot.wa.gov/environment/eao/wqec/wqec_water.htm.

Office Data Recording And Analysis

All project water quality monitoring forms, maps, and pictures of the sampling stations are kept in a single file in the project office for easy access for compliance inspections or peer review of the documentation. Standard forms for recording and reporting monitoring results can be downloaded from the WSDOT Water Quality Program website (http://www.wsdot.wa.gov/environment/eao/wqec/wqec_water.htm). These forms, in Microsoft Excel format, summarize data for each point of compliance and generate graphs for monthly reports.

Initial data analysis occurs in the field, comparing results with water quality standards in the Daily Data Record Form. The summary report data and graphs should identify trends and evaluate the effectiveness of BMPs.

Reporting Sampling Results and Compliance Issues

If sampling results indicate that a project is not in compliance with water quality standards or permit(s) conditions, the following procedures should be followed:
Note the noncompliance issue, the results, the duration of the noncompliance issue, time of day, and characteristics of the activity causing the noncompliance.
Immediately notify the Project Engineer or appropriate WSDOT contract inspector, and the regional environmental office to inform them of the situation and possible consequences, and discuss potential corrective actions. The designated point of contact as determined within each region reports the incident and the effectiveness of corrective actions to regulatory agencies.
Notify Headquarters Water Quality Program.
If a spill is observed while sampling, immediately report it to the lead inspector, project engineer, and regional environmental contact so that legal reporting requirements can be met and trained cleanup staff can be contacted if necessary.

Send electronic copies of summary report data and graphs to the Project Engineer, the regional environmental office, and the Headquarters Water Quality Program on a monthly basis. The report should include a short narrative whenever water quality standards were not met, including what actions were taken to correct problems. The Project Engineer's designated contact person sends results to regulatory agencies whenever standards are not met and as required by permit.

Water Quality Sampling Equipment Information

Company	Product	Approximate Cost
Hach Company (970) 669-3050 www.hach.com	2100 p Turbidimeter SensION1 pH and Temperature meter	$800 $500
(Or any major scientific supply distributor)		

1.3.7 State Standards

There are numerous water quality standards listed in 173-201A WAC including standards for turbidity, pH, dissolved oxygen, temperature, etc. However, turbidity and pH are the most common parameters associated with enforcing water quality standards on construction projects.

Turbidity is measured in nephelometric turbidity units (NTU) using a turbidimeter. A turbidimeter works by measuring the amount of light that is deflected by the suspended material in the test sample. Pure water has a turbidity of zero, while muddy water can have turbidity as high as 1000 NTU to several thousand NTU.

Turbidity standards for discharges to surface waters vary with the turbidity of the receiving waters. For most state waters the water quality criteria for turbidity and general water quality is as follows:

- Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
- Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

The acidity or alkalinity of discharge water from construction sites, measured as pH, is monitored because elevated levels can directly harm aquatic resources. The pH scale ranges from 0 to 14, with a pH of 7 being neutral. Levels higher than 7 are alkaline and lower than 7 are acidic. Construction projects are most likely to have more alkaline or elevated pH levels as a result of concrete grinding, saw cutting, concrete placing, and truck washing, for example. The standard for pH is no increase greater than 0.5 over background.

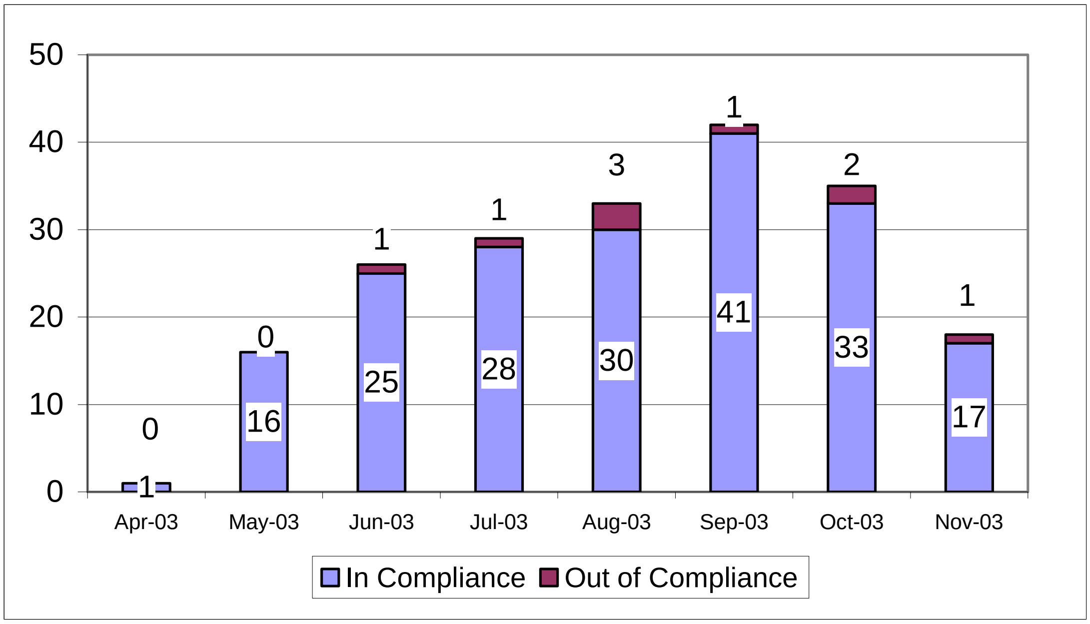
Mixing zones may be allowed under certain conditions on some sites. A mixing zone is defined in state law as “that portion of a water body adjacent to an effluent outfall where mixing results in the dilution of the effluent with the receiving water. Water quality criteria may be exceeded in a mixing zone as conditioned and provided for in WAC 173-201A-100.” The use, size, and location of mixing zones are established in permits or orders by the Department of Ecology.

1.3.8 Statewide Monitoring Results

In 2003, WSDOT completed its first year of construction site water quality sampling under a new statewide monitoring policy. The policy requires sampling on at least 20 percent of all projects with substantial potential for water quality impacts. The chart at right summarizes sampling results that compare water quality upstream and downstream from 12 projects. Ninety-five percent of the samples met water quality standards for clarity.

Of the 200 samples taken, nine failed to meet standards. The water became muddy on five of the projects because work had to be done in the water or very near the shore. The other four projects experienced heavy rainfall ranging from ¾ to 3 inches, which overwhelmed the mandated design capacities of approved treatment facilities. In all cases, monitoring results prompted immediate corrective actions to regain compliance with water quality standards.

Figure 1.3.8 Turbidity Compliance 2003



1.3.9 Site Assessments

In addition to education, careful planning and stringent contract requirements, WSDOT routinely performs construction site assessments to verify the effectiveness of erosion control measures and makes improvements as needed. In the fall of 2003, moderate and high-risk projects (20 in all) were inspected to determine how well they were prepared for the wet season and whether or not erosion led to any water quality violations, site damage, or delays.

Table 1.3.8 outlines how well prepared WSDOT was during fall 2003 compared to its level of preparation in 2002. Last year WSDOT identified areas where improvements in erosion control preparedness were needed. One area in particular included ensuring that erosion control plans are always on site and up to date with current project conditions (a condition of environmental permitting). Specific actions were taken at statewide meetings and training sessions that resulted in an improvement of 19 percent.

In 2003, the overall assessment increased in three areas, while it remained the same or had little change in seven others. WSDOT's preparedness in the remaining eight areas decreased substantially creating an elevated risk to increased erosion when compared to the previous year. The decrease in the bottom five areas in the "Poor" category are directly attributed to one or both of the following reasons: (1) the extremely dry weather last fall extended large earthwork activities into the "wet season," delaying soil cover practices and (2) drought conditions reduced effectiveness of late spring and early fall seeding applications.

Table 1.3.9 Site Assessment Results

	Erosion and Sediment Control Assessment Results	2002	2003	Status
Excellent	Delineate Clearing Limits – MR #2	100%	100%	stable
	Utility Trench Construction – MR #9	100%	100%	stable
	Removal Of Temporary BMPs – MR #11	81%	100%	improved
Good	Contractor trained in proper use of erosion/sediment control measures – Standard Specification 8-01.3(1)B	100%	95%	decreased
	Sediment Control BMPs Installed On Time – MR #4	90%	90%	stable
	Control offsite erosion by controlling flows – MR #6	87%	84%	decreased
	Storm Drain Inlet Protection – MR #8	74%	82%	improved
Fair	If a storm hit at time of site visit, water would meet state water quality standards – Internal WSDOT measure.	86%	80%	decreased
	Protect Adjacent Properties & Waters Of The State – MR #3	83%	80%	decreased
	Effectiveness of measures installed to trap sediment – MR #1b	96%	78%	decreased
	Erosion control plans are on site and up to date for all WSDOT projects – Standard Specification 8-01.3(1)B	56%	75%	improved
Poor	Dewatering – MR #12	100%	71%	decreased
	Maintain BMPs – MR #13	70%	70%	stable
	Construction access routes stabilized to prevent tracking of mud onto streets – MR #10	98%	69%	decreased
	Effectiveness of measures installed to prevent erosion – MR #1a	91%	67%	decreased
	Temporary stormwater conveyance channels stabilized – MR #7	90%	64%	decreased
	Protect Cut & Fill Slopes – MR #5	67%	50%	decreased
	Amount of disturbed soil actually covered with erosion control measures – MR #1a	65%	45%	decreased

1.3.10 Reporting Non-Compliance – Instructional Letter 4055

This course is designed to help you keep your construction projects in environmental compliance. There will be times, however, when problems will arise despite the best efforts to implement BMPs. Regardless of the reason, if site runoff fails to meet water quality standards, the notification procedures described in WSDOT Instructional Letter 4055 must be implemented immediately by the contractor and WSDOT management. This IL describes "notification triggers" and follows a step-by-step notification procedure from the contractor who discovers the problem to the WSDOT Regional Administrator and director of Environmental Services.

Purpose

The purpose of the Environmental Compliance Assurance procedure is to recognize and eliminate environmental violations during the construction phase on Washington State Department of Transportation (WSDOT) construction sites, and to ensure prompt notification to WSDOT management and agencies. For purposes of this procedure, violations are defined as actions that are not in compliance with environmental standards, permits, or laws.

Procedure Overview

When any action (Notification Trigger) below occurs or if there are questions about compliance, the Project Engineer (PE) shall initiate this procedure to develop corrective actions to solve the identified problem. The Regional Environmental Manager (REM) will serve as a resource to the PE and give priority to addressing the actions, activities, or situations that stem from notification triggers. The PE and REM will work together on an appropriate response to the notification trigger to avoid or minimize environmental damage.

A. Notification Triggers: "Notification Triggers" (listed below) means an action, activity, or situation that requires the Project Engineer to implement the Environmental Compliance Assurance Procedure.

1. Notice from a resource agency that a violation has occurred;

2. Any action that, in the judgment of the REM, contractor or Project Engineer, may violate environmental permit conditions, agreements, or approvals for the project; or other environmental laws, ordinances, or regulations;

3. Any unauthorized work, activity, or fill in wetlands, shorelines, creek beds (including dry channels), other waters of the state, or critical habitat;

4. Any emergency protection activity that involves unauthorized placement of fill in wetlands, shorelines, creek beds (including dry channels) or waters of the state or for bank stabilization activities where fill or structures are placed on the bank;

5. Any action or project revision requested by an agency after a site inspection that may be in conflict with other permits;

6. Any spill, discharge or release of hazardous materials, oil, or chemicals to land or water;

7. Any situation that results in a fish kill, or if dead or dying fish are discovered in the vicinity of the project;

8. Activities that monitoring shows are out of compliance.

B. Notification and Resolution Process: In the event of a notification trigger, the following steps shall be taken:

1. If a notification trigger is observed first by the contractor or REM, the contractor or REM shall immediately notify the **Project Engineer**.

2. The Project Engineer must:

Step 1. Immediately notify the Contractor of the situation, implement emergency response procedures including agency notification, and suspend all non-conforming work on the site.

Step 2. Immediately notify the Regional Environmental Manager (REM). Consultation with the REM must occur before any remediation actions are taken.

Step 3. In consultation with REM assemble the following information:

a. The activities that triggered the notification and why they occurred.
b. Location of the work.
c. Potential solutions to the problem, or if additional investigation is needed, the agreed upon course of action.
d. Any related site constraints or safety issues.
e. Urgency of the issue

Step 4. Notify his or her immediate supervisor.

Step 5. Notify the Regional Administrator (mandatory when a serious violation has occurred).*

Step 6. In consultation with the REM, determine the resource agencies having jurisdiction and who will notify them.

Step 7. Document all actions, conversations and activities.

3. The Regional Environmental Manager must immediately:

   Step 1 Notify the Director of Environmental Services (mandatory when a serious violation has occurred).

   Step 2. Notify his or her immediate supervisor.

   Step 3. Work with the Project Engineer to resolve the issue that caused the notification trigger.

   Step 4. Identify and obtain appropriate permits or permit revisions with the aid of the Project Engineer.

   Step 5. Document all actions, conversations, and activities. Communicate issues and send appropriate documentation to Regulatory and/or Resource Agencies.

4. The Director of Environmental Services must immediately (mandatory when a serious violation has occurred)*:

   Step 1. Notify Compliance Branch Manager and any other EAO Program Managers associated with the resource issue.

   Step 2. Notify Director of Environmental & Engineering Programs.

   Step 3. Notify the Regional Environmental Manager that the Director of Environmental & Engineering Programs has been contacted.

   Step 4. Regional Environmental Manager must then notify the Project Engineer that the violation reporting procedure has been completed.

5. The Regional Administrator will (mandatory when a serious violation has occurred)*:

   Step 1. Coordinate with the Director of Environmental & Engineering Programs to contact the Assistant Secretary of Engineering and Regional Operations advising him or her of the situation, and provide updates as needed on the situation.

   Step 2. Ensure that the Project Engineer and the Regional Environmental Manager have the necessary resources, authority and organizational support to successfully resolve the environmental problem.

C. **Timing:** Due to costs of project delays, or risk of not acting quickly during emergency situations, the REM shall provide a 24-hour contact person for environmental consultation.

D. Documentation:

1. The Project Engineer shall document the details of the notification and problem resolution in the contract records.

2. The Regional Environmental Manager shall maintain a record of all regional non-compliance events. REMs shall collect and maintain, at a minimum, the following data on all non-compliance events:

   a. Project Name and location
   b. PE and Prime Contractor
   c. Incident Date
   d. Incident Description
   e. Permit/Regulation Violated
   f. Resource Agency(s) notified and date of notification
   g. Whether or not resource agency staff conducted site review in response to notification
   h. Record of NOVs and/or penalties issued

   The REM shall provide all regional non-compliance tracking data to ESO Compliance Branch Manager for the purposes of annual reporting and review of compliance performance.

3. For violations, the appropriate documentation needed to record the violation, and achieve resolution, including any preliminary mitigation solutions, will be collectively developed by the Project Engineer and the Regional Environmental Manager, and shall be coordinated with and sent to the appropriate regulatory and/or resource agency (mandatory when a serious violation has occurred).*

E. Roles and Responsibilities:

1. "Project Engineer" is the person responsible for the project and administration of the construction contract. This responsibility may be delegated to a subordinate employee on site, but the ultimate responsibility for making sure these procedures are followed will be with the Project Engineer. The Project Engineer shall have a thorough knowledge of all of the environmental permit conditions and design requirements for the project, and have such certifications and other qualifications as may be required.

2. “Regional Environmental Manager” is the person responsible for administering the regional environmental program. This responsibility may be delegated to a subordinate employee with knowledge of environmental permitting and procedures, but the ultimate responsibility for setting and interpreting regional environmental policy will be with the Regional Environmental Manager.

3. “Contractor” is as defined in Section 1-01.3 of the Standard Specifications for Road, Bridge, and Municipal Construction (2002).

* Denotes that the action is mandatory when the violation 1) results in agency enforcement staff coming on site to conduct enforcement review; and/or 2)there is a high likelihood the event will result in NOVs or penalty.

Section 2

2.1 Definitions and Basic Principles of the Erosion/ Sedimentation Processes

2.1.1 Definitions

Erosion The process in which, by the actions of wind or water, soil particles are displaced and transported.

Sediment Eroded material suspended in water or wind.

Sedimentation The deposition or settling of eroded material.

Turbidity Having suspended solids, including sediment and organic matter in water (i.e., muddy).

2.1.2 Erosion Process by Water

Raindrop The impact of raindrops on bare soil displaces soil particles. Over the duration of a storm, significant volumes of sediment are made available to be transported.

Sheet As rain accumulates a non-concentrated, uniform layer of runoff is formed. This sheet flow transports detached soil from raindrop impacts, as well as plucks off additional soil particles caused by the shear stress of the runoff.

Rill When sheet flows converge, increased volumes and velocities of water are concentrated. Small, intermittent watercourses with steep sides, known as rills, are formed. They are usually only a few inches deep.

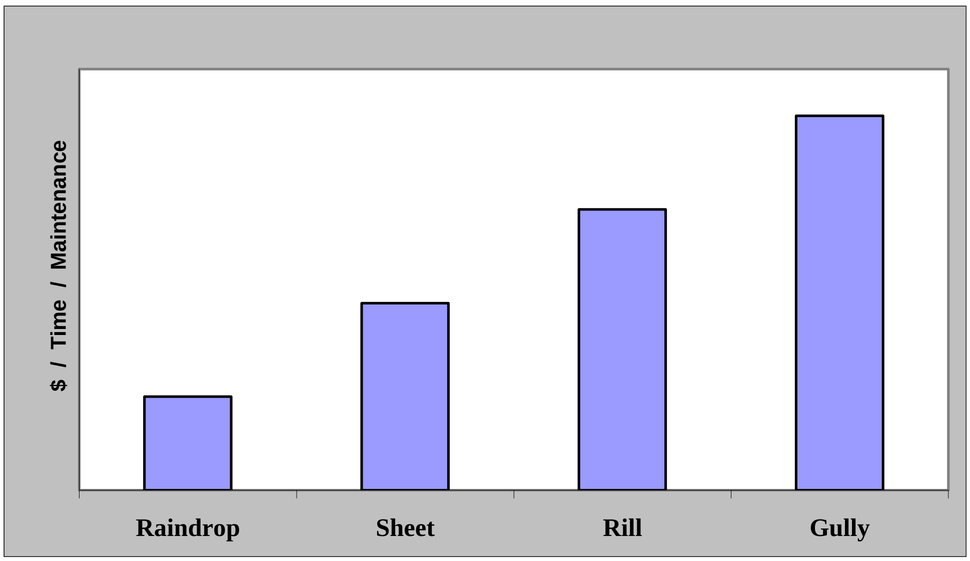
Gully When rills converge and/or impervious surfaces focus runoff in a single location, a large channel, known as a gully, is formed. Volumes and velocities of water, along with shear stress are increasing dramatically.

Stream Bank Bank erosion of existing streams/channels is caused by increased peak flows.

Erosion Process Influence On BMPs

The volumes and velocities of runoff at the raindrop and sheet flow phases are relatively low and as a result, they are often referred to as “low energy” phases. The rill and gully phases are often referred to as “high energy” because of the greater volumes and velocities. Therefore, if erosion control efforts are focused at the “low energy” phases, less expensive BMPs can be used, less time will be spent implementing them, and less maintenance will be needed. The opposite is true if too much reliance is put on sediment control in place of prevention.

Figure 2.1.2 Erosion Process Influence On BMPs



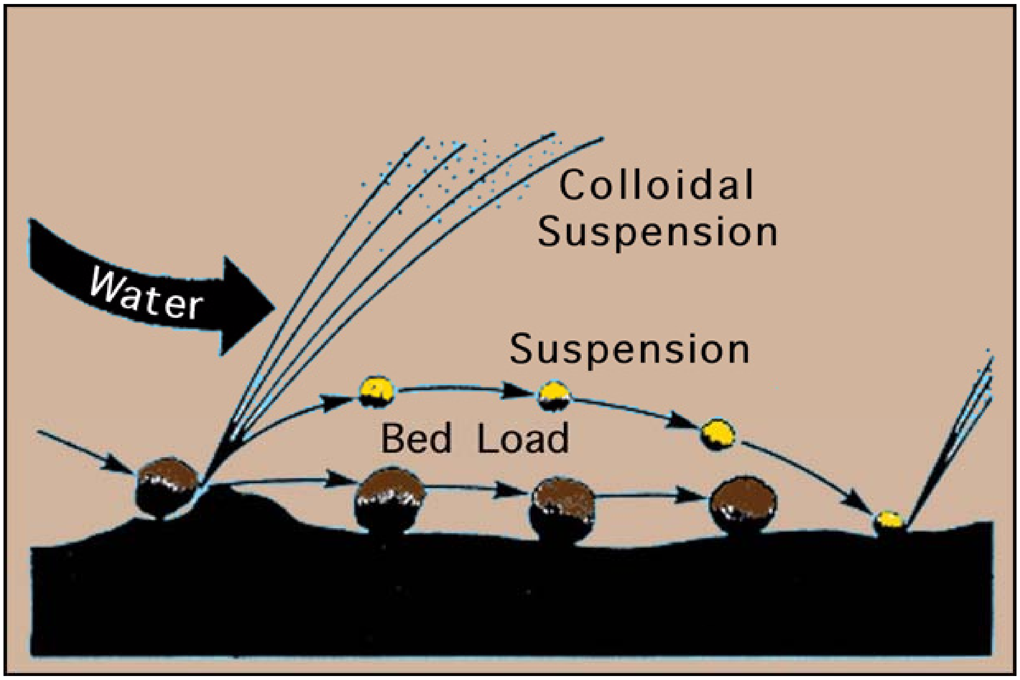
2.1.3 Sediment Movement by Water

Bed Load - Soil particles that are dragged, rolled, skipped, or saltated.

Suspension - Soil particles that are lifted up by the flow energy and moved long distances down stream before settling to the bed.

Colloidal Suspension - Same as suspension but includes only the fine, colloidal soil particles that may never settle to the bed.

Figure 2.1.3 Sediment Movement (Water)



2.1.4 Erosion Process by Wind

As is the case with water erosion, the loss of soil by wind movement involves the detachment and transportation processes. The lifting and abrasive action of the wind results in some detachment of tiny soil grains from the granules or clods of which they are a part. When the wind is laden with soil particles, however, its abrasive action is greatly increased. The impact of these rapidly moving grains dislodges other particles from soil clods and aggregates. These dislodged particles are now ready for movement.

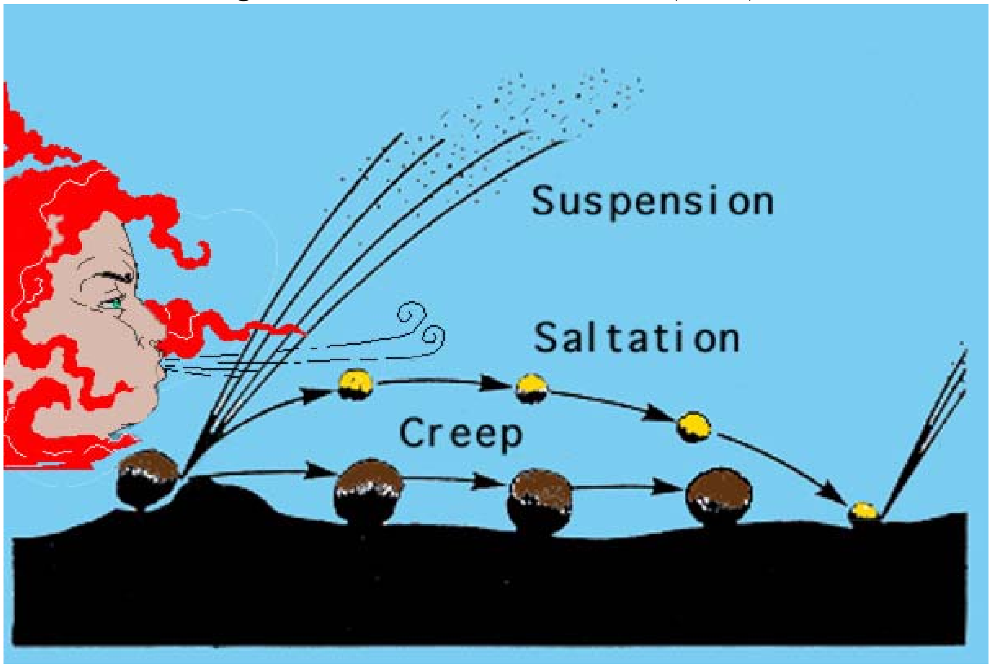
2.1.5 Sediment Movement by Wind

Saltation – The most important of the mechanics of wind erosion is saltation, defined by soil particles bouncing short distances. They remain close to the ground, usually no higher than twelve inches. Depending on soil conditions, saltation may account for 50-70% of total erosion.

Surface Creep – Saltation encourages surface creep, which is the rolling and sliding along the surface of larger soil particles. Not only is surface creep initiated by saltation, it is actually prolonged by the ricocheting action of saltating particles. Surface creep may account for 5-25% of total erosion.

Suspension – Dust particles of fine sand size or smaller are moved parallel and upward to the ground surface. Suspension can reach ten feet to many miles into the sky. Very fine particles are lifted from the surface by impact/saltation and carried high into the air, remaining suspended in air for long distances. Although it is a spectacular and visible method of transporting soil, it may account for only 15% of total erosion.

Figure 2.1.5 Sediment Movement (Wind)



2.2 Factors that Control Erodibility

- Soil
- Precipitation
- Vegetation
- Surface Area
- Slope Length & Gradient
- Surface Texture

Basin area, vegetation type, amount and type of precipitation, soil characteristics, gradient and slope length all contribute to the amount of soil lost to erosion. On any given site and project you will be able to control some of these factors, but not others. They can be compared to the knobs on a control panel and one of the first tasks of erosion control planning is to determine which knobs are adjustable.

For example, slope length and gradient can often be controlled through project design, or by terracing or otherwise breaking up a slope. Soil type is usually not controllable except when soil is imported for fill. Likewise, you can't change precipitation, but scheduling to avoid periods of high probability of rainfall provides some control over this factor. For any project and site consider the contribution each of these factors will make to potential erosion, and which of those you can control to reduce that potential.

2.2.1 Soil

Soil Texture

Soil contains varying combinations of sand, silt, and clay. The overall combination of these minerals is referred to as soil "texture." For example, a soil with 50% sand, 19% silt, and 31% clay is called a "sandy clay loam" (see soil triangle). Two important characteristics of texture are cohesion and infiltration.

Cohesion is the ability of soil particles to bind together. As it increases, erosion potential decreases. Sands are large, heavy particles that are loosely packed together. Silts consist of medium sized particles, which are moderately packed together. Clays are extremely small, tightly packed particles.

Infiltration is the ability for soil to absorb water and is a function of soil texture. Water infiltrates rapidly in coarse textured, highly porous soils such as sands, while fine textured soils like silt and clay will infiltrate little if any water. Groundwater seeps and mudslides are often found in association with fine textured soil due to limited infiltration in those layers.

Water and wind erosion are similarly affected by texture. Sands and silt are more susceptible due to less cohesion than the tightly packed clay particles.

Erosion Potential Evaluation Methods

The following methods are used to determine site-specific erosion potential based on soil texture. These include the following methods: (1) county soil surveys, (2) geotechnical reports, (3) jar test in combination with soil triangle, and (4) hand texturing.

1. County Soil Survey

The Natural Resource Conservation Service (NRCS), formerly the Soil Conservation Service, has developed maps for Washington State that show the specific soil classification for any given location. These maps are compiled by county and are typically available from the regional NRCS office, local conservation district, or Washington State University Cooperative Extension office. To determine which soil group to use for an analysis, locate the project site on the NRCS map and read the soil classification that is listed. Section 2.3.1 of the Erosion Control Designers Course contains additional information to evaluate risks related to soils.

<u>Hydrologic Soil Groups</u>
Soil is categorized into four hydrologic soil groups to estimate stormwater runoff. Soils are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms. The four hydrologic soil groups are:

Group A
Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands.

Group B
Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well-drained soils that have moderately fine texture to moderately coarse texture.

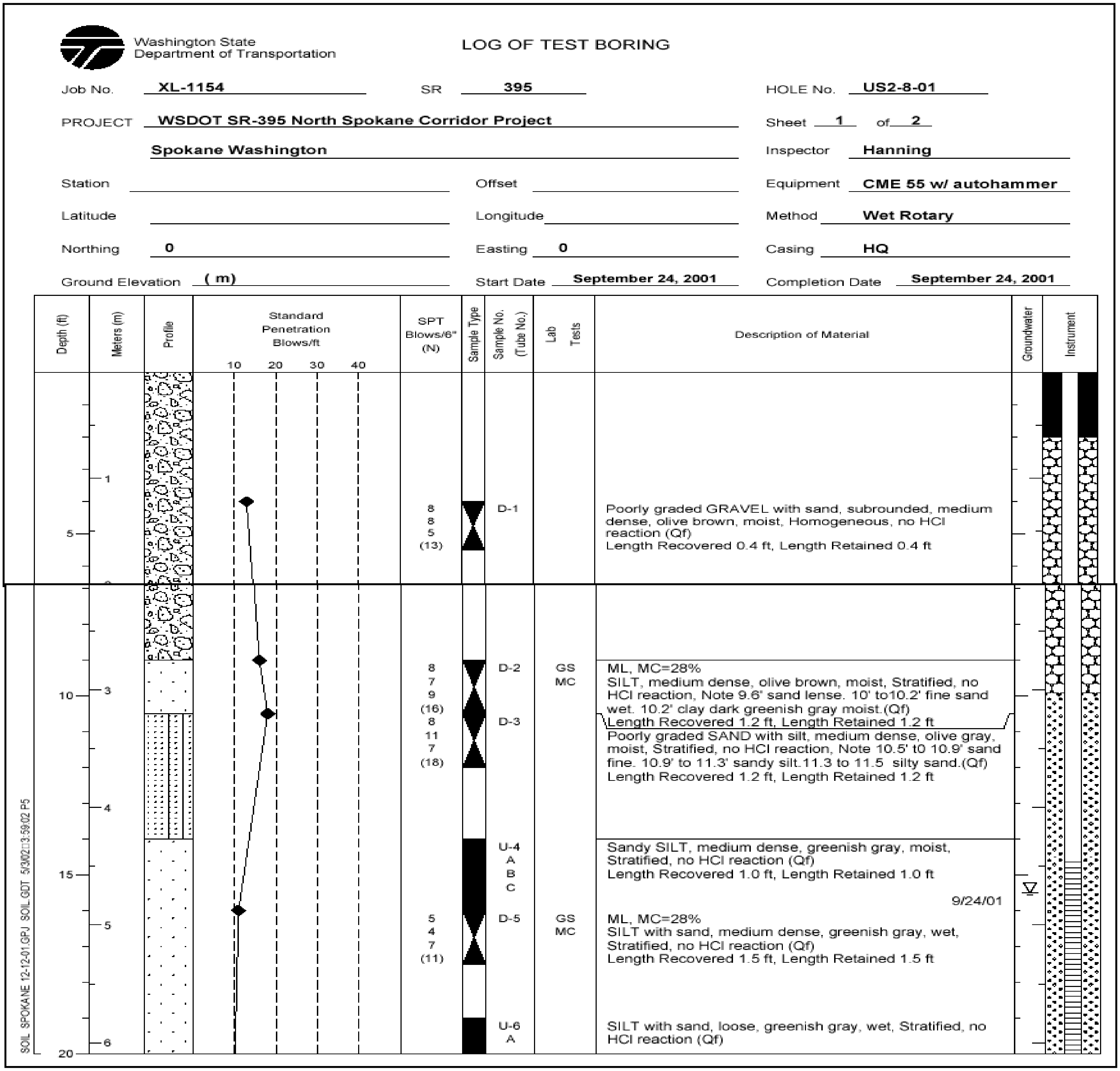
Group C
Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture.

Group D
Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have high shrink-swell potential, soils that have a permanent high water table, soils that have a clay pan or clay layer at or near the surface, and soils that are shallow over nearly impervious material.

2. **Geotechnical Reports**

These usually give detailed descriptions of soils including soil grain size, which refers to the actual sizes of the individual particles (i.e., sand, silt, clay) making up the sediment portion of the soils. The grain size distribution of a given sample of sediment or soil is most often reported as a series of percentages (for each size class) of the overall sample mass or weight. Knowing the grain size and structure can lead to understanding the porosity of the soil and its ability to hold moisture.

Figure 2.2.1.A Log of Test Boring



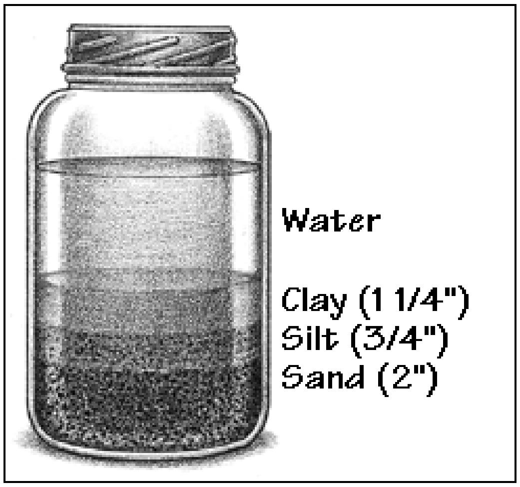
3. Jar Test/Soil Triangle

One way to determine soil texture in the field involves using a jar and soil triangle. This method involves the following steps.

Step 1

Fill a quart jar with equal parts of soil and water; shake vigorously, then let it stand. The largest particles (sand) will settle out in about a minute. Silt will take about an hour, while clay may take all day. Measure the depth of each layer, and divide by the total depth of the soil to get a percentage for each component.

Figure 2.2.1B Jar Test



Example			To Find Percentages
Total depth	=	4 inches	
Sand layer	=	2 inches	Sand: 2 divided by 4 = 0.50, or 50%
Silt layer	=	¾ inch	Silt: 3/4 divided by 4 = 0.19, or 19%
Clay layer	=	$1^1/_4$ inches	Clay: 1.25 divided by 4 = 0.31 or 31%

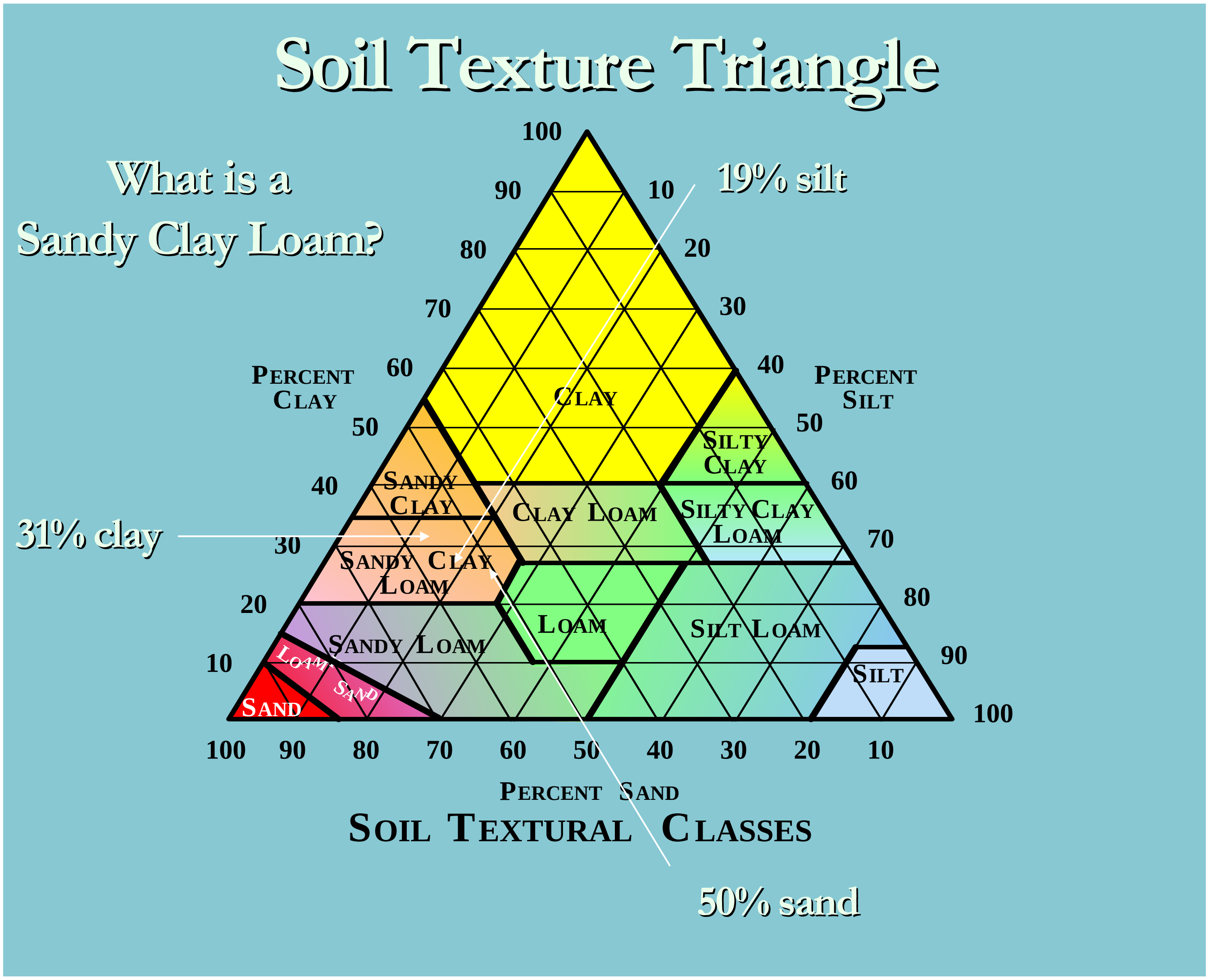
Step 2

Plot the results of your soil test on the soil-texture triangle. Draw a line from each scale (clay, silt, or sand) that starts at the approximate percentage and runs parallel to the triangle side at the 0% end of the scale. In the example shown here, lines from 31% on the clay scale, 19% on the silt scale, and 50% on the sand scale meet to identify the soil as "sandy clay loam."

Example

- 50% Sand
- 19% Silt
- 31% Clay = Sandy Clay Loam

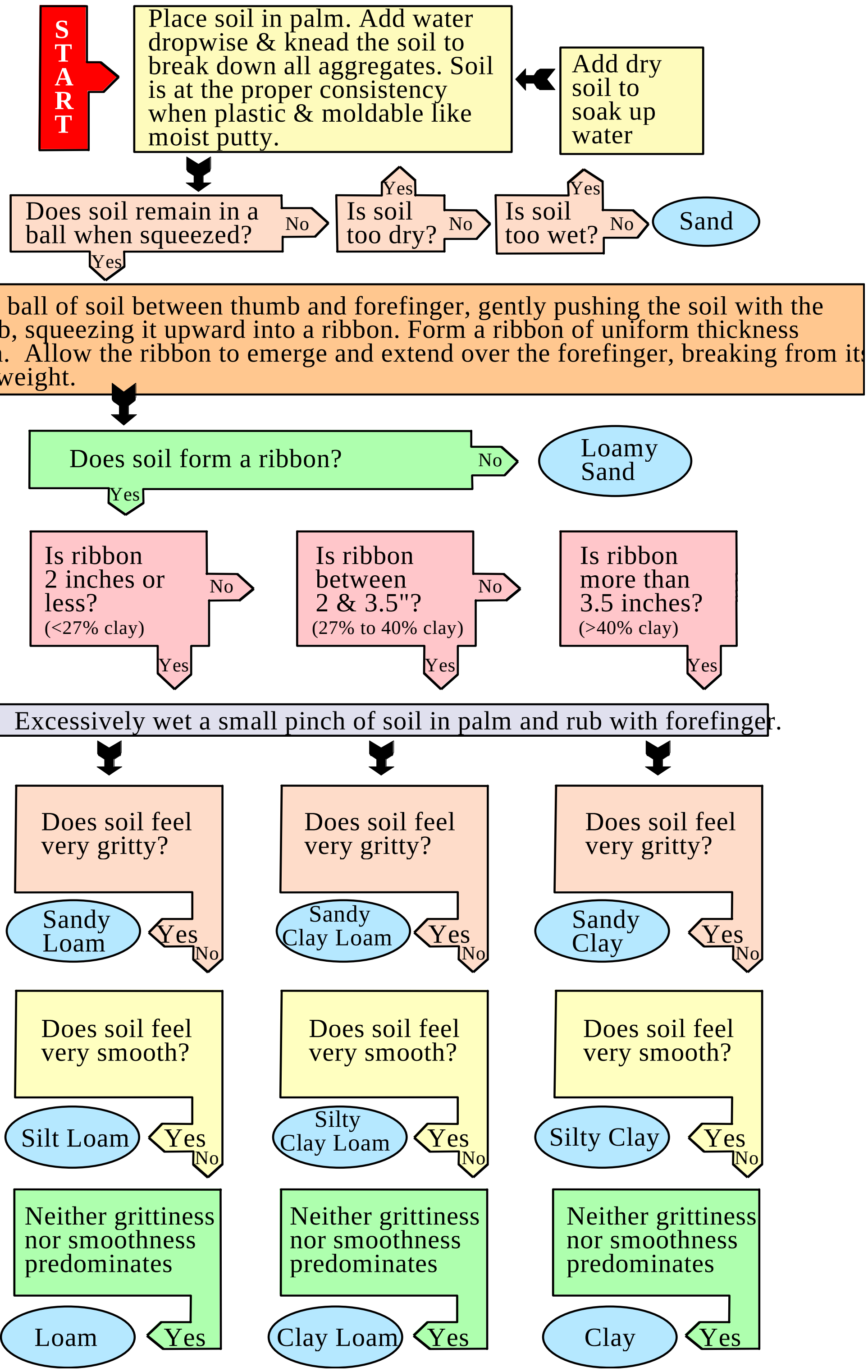
Figure 2.2.1C   Soil Texture Triangle



4. Hand Texturing

Another field sampling method to determine soil texture is hand texturing. For this method, a representative soil sample is rolled into a ball and the flow chart provided on the next page is followed. While not as precise as some of the other methods mentioned above, hand texturing can give a rough estimate of a soils texture and how that soil might affect erosion.

Figure 2.2.1D   Hand Texturing



Influence of Soil Texture On Turbidity

Soil texture greatly influences the turbidity of construction runoff. The rate at which eroded soil particles settle out of solution as sediment is largely determined by the size of the particle. Larger particles weigh more and settle faster, whereas, smaller particles weigh less and settle more slowly. Extremely small particles form colloidal suspensions that do not settle out for years or centuries. Settling rates for a wide range of soil particle sizes is indicated on Table 2.2.1.

Table 2.2.1 Settling Velocities Of Soil Particles In Still Water

Diameter of Particle (mm)	Order of Size	Settling Velocity (mm/sec)	Time Required to Settle One Meter (3.28 Ft)
10.0	Gravel	1.000	1.0 Seconds
1.0		100	9.8 Seconds
0.6	Coarse Sand	63	15.0 Seconds
0.3		32	30.0 seconds
0.15	Fine Sand	15	67.0 Seconds
0.015		0.35	47.6 Minutes
0.010	Silt	0.154	107.0 Minutes
0.003		0.0138	20.1 Hours
0.0015	Clay	0.0035	79.0 Hours
0.001		0.00154	180.0 Hours
0.0001		0.0000154	754.0 Days
0.00001	Colloidal Particles	0.000000154	207.0 Years
NOTE: Temperature 50°C; all particles assumed to have a specific gravity of 2.65.			

Fine textured soils contain a high proportion of small soil particles that, once suspended, create turbid runoff that requires long settling times to clarify. Such runoff is very difficult to clarify using standard sediment control BMPs.

Coarse, sandy soils are easily eroded, but suspended particles rapidly settle due to their larger size. Therefore, sites with sandy soils may experience severe erosion yet have low turbidity runoffs, especially when effective sedimentation control BMPs are used.

2.2.2 Precipitation

The frequency, intensity and duration of precipitation events affect erosion potential. It is important to know the precipitation patterns when preparing and implementing TESC plans. Knowing one rainfall variable alone is insufficient. All three factors must be evaluated to accurately assess the potential for erosion. Seasonal variations for each of these factors must also be considered.

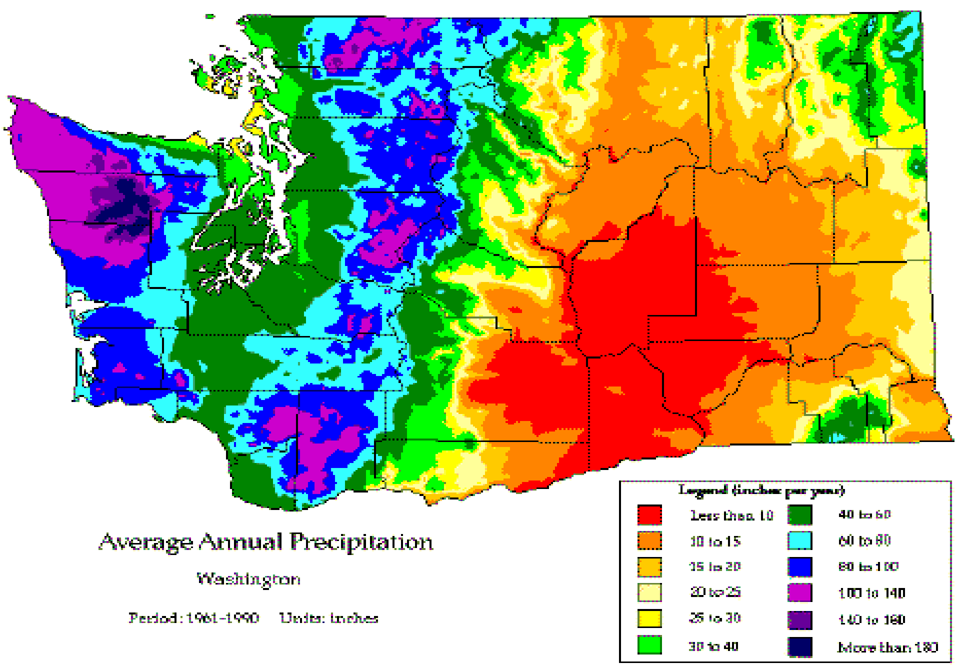
<u>Frequency</u> - Higher frequency precipitation events may expose a site to greater potential for erosion because of its influence on saturation within the soil. Once the soil is saturated it takes less precipitation to cause erosion because more water is flowing on top of the soil surface rather than infiltrating.

<u>Intensity</u> - High intensity rainfall events have the greatest potential for erosion for two reasons. First, high intensity rainfall events cause the most severe raindrop erosion. Secondly, high intensity rainfall events create flashy, large runoff volumes. This runoff usually collects as high energy, concentrated flow that can cause rills, gullies, and damage to drainage features.

<u>Duration</u> - Duration of precipitation events also affects the potential for erosion because of the ability to saturate the soil. Saturated soil conditions increase the potential for both increased surface runoff volumes and mudslides. A given amount of rainfall at the end of a prolonged rain event often does much greater damage than the same amount of rain at the beginning of the rain event.

Moisture content of the soil is critical when determining its susceptibility to wind erosion. Figure 2.2.2A illustrates how dust control issues may vary around the state.

Figure 2.2.2B Average Annual Precipitation



Available Rainfall Data on the Internet

Knowing the expected rainfall for any given area and time of year can be critical. Forecasts provide an idea of the weather for the next few days, but statistical data, based on past rainfall records, is needed to help identify long-term trends.

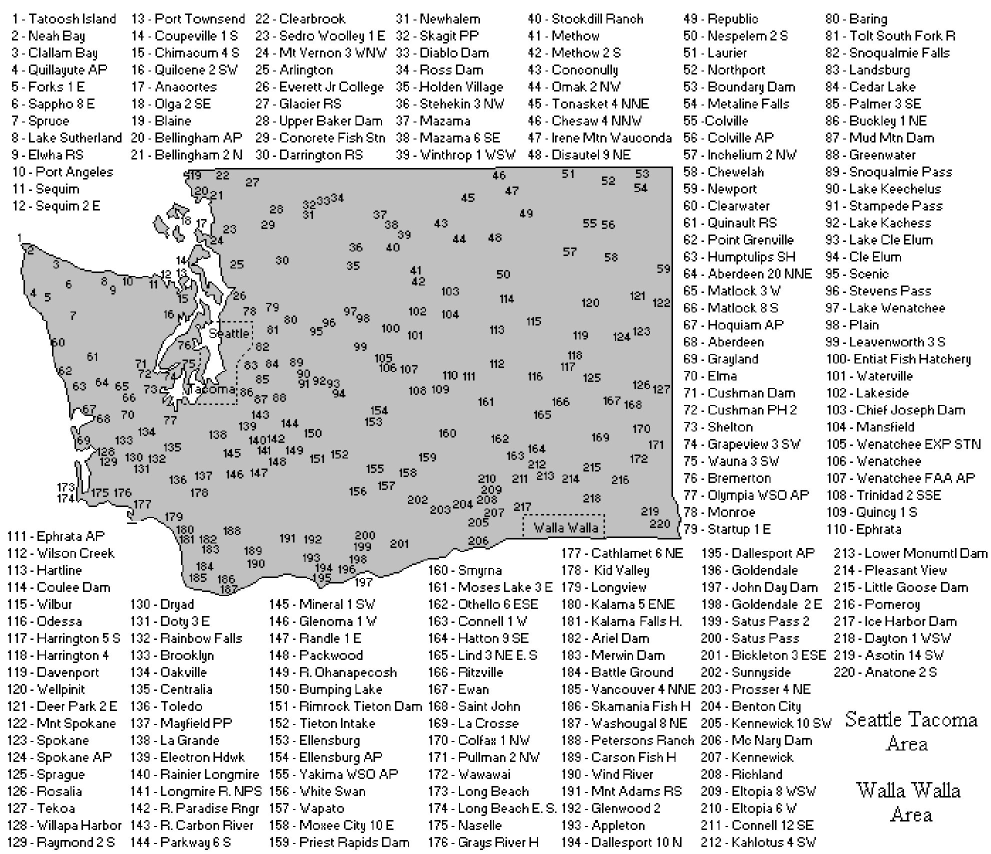
The Western Regional Climate Center has statistical information on precipitation, temperature, and several other measurements available on their web site. Included on their site is tabular and graphical information as well as interactive probability graphing capabilities.

Of particular interest to WSDOT designers, inspectors, and project managers are the Average Total Monthly Precipitation graphs. These graphs are available for over 200 sampling stations throughout the state and can be copied and pasted into Stormwater Site Plans, Temporary Erosion and Sediment Control Plans, Water Quality Monitoring plans, and other documents that address stormwater and its potential for impacts on the environment.

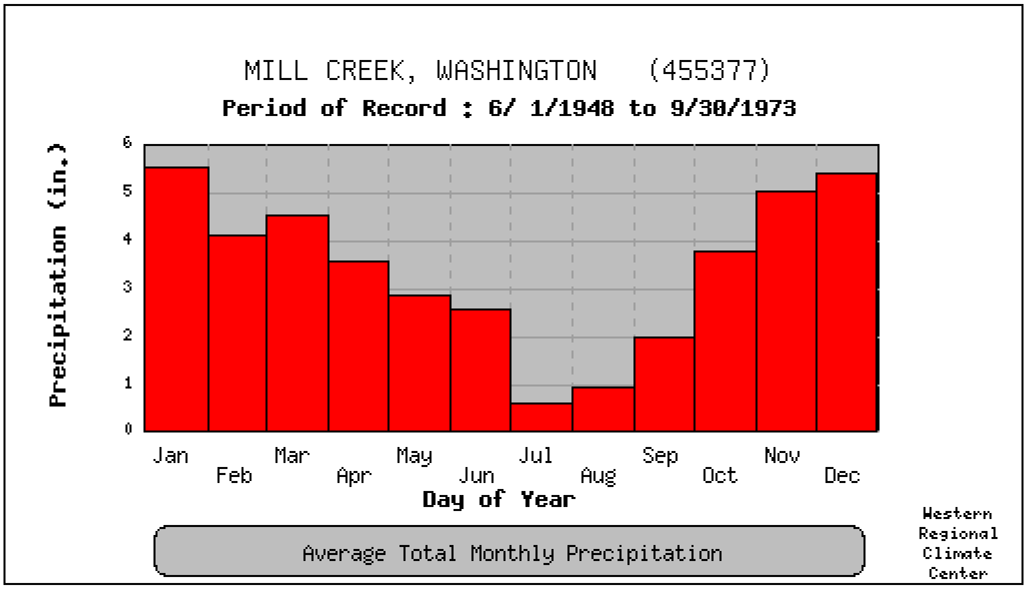
The address for the Western Regional Climate Center summaries is:
http://www.wrcc.dri.edu/summary/climsmwa.html.

At this address an alphabetical list of all the sampling stations is available in the left frame and an interactive map (Figure 2.2.2B) showing their locations in the right frame. Linking to a station by clicking on the list name or on the map location is available.

Figure 2.2.2B Washington State Rain Gauge Stations

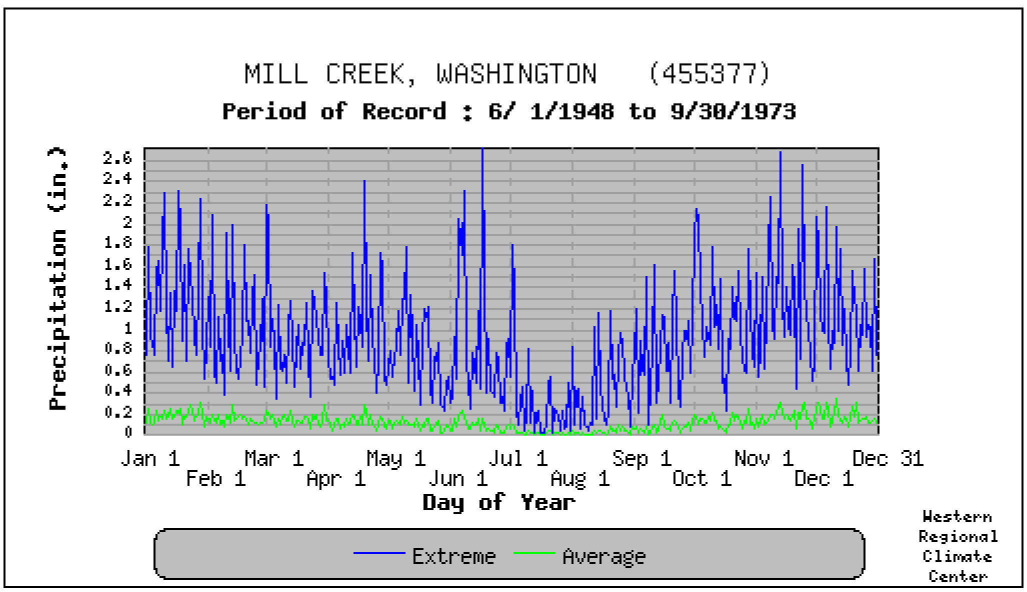


The following example has been selected to demonstrate the graphing capabilities of this website.

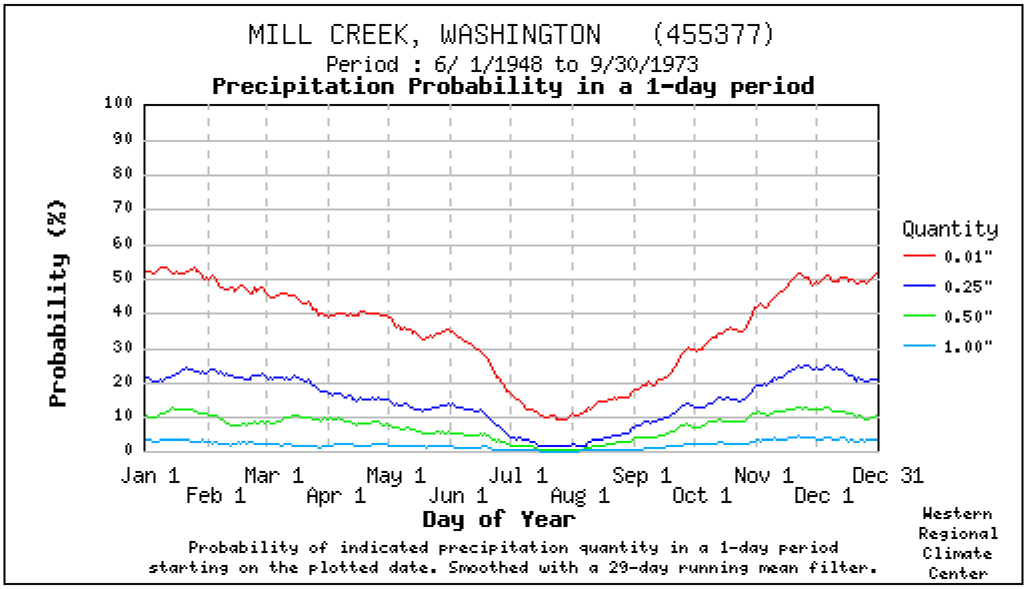


Average monthly totals give a good starting point to determine how projects should be phased and at what times of year the site should be most heavily protected.

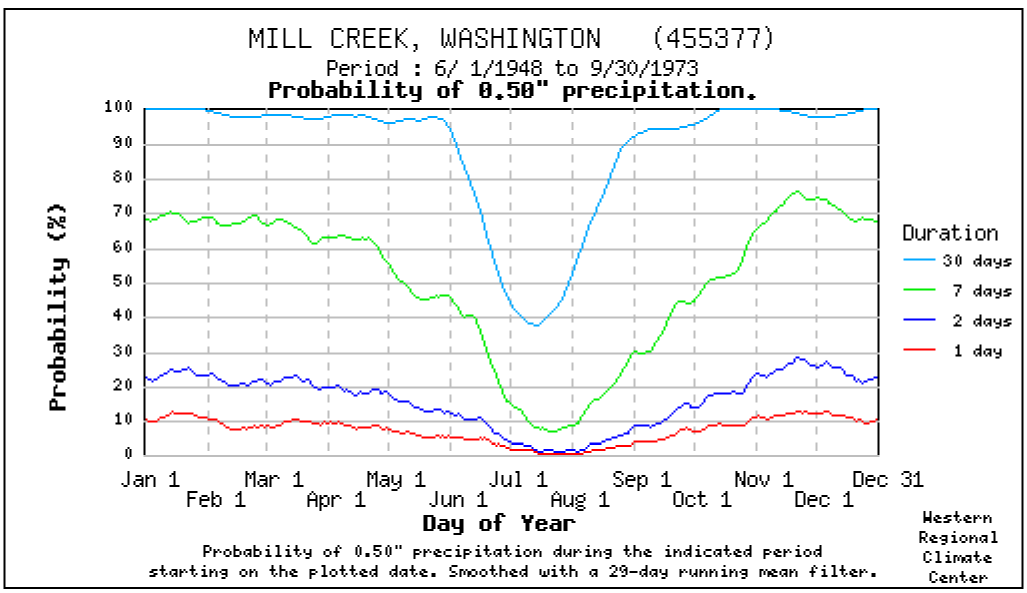
Extreme events, not averages, are responsible for severe erosion problems. Note that the frequency of extreme events is highest during the wet season, yet extreme events happen throughout the year.



The probability of extreme events (any rainfall quantity) can be checked for risk assessment during construction.



The risk of erosion increases with the duration of time that soils are exposed. Tables can be made to asses risk with any rainfall amount over any given time period. Note how the 2-day soil cover requirement keeps the risk of exposed soils from getting hit with 0.5 inches of rain to 20-30% in the wet season. Soils left uncovered for 7 days in the wet season (especially the fall) have a 50-75% probability of getting hit with enough rain to cause serious erosion. Soils exposed for a month in the wet season are virtually guaranteed (>95-100% chance) of getting hit with a ½-inch storm event.



2.2.3 Vegetation

Runoff Volume

Well-vegetated areas experience little erosion. Rain is intercepted by the tree canopy and evaporates back into the atmosphere. The canopy also decreases the evaporation of water from the soil, making it less susceptible to wind erosion. Plant roots increase the porosity of soils increasing infiltration rates. Forest floor material such as moss, pine needles, twigs, dead grass, and rotten wood absorb water and decreases ground level wind speeds.

Flow Velocity

The velocity of stormwater runoff slows down due to surface friction created by vegetation and other material on the forest floor.

Sediment Filtration

Vegetation and litter (dead plants) serve as natural filters, catching suspended materials in runoff.

Energy Absorption

Vegetation and litter absorb the energy of falling raindrops, reducing raindrop erosion. Roots, vegetation and litter break up flows reducing runoff energy below levels that cause erosion.

Soil Retention

Roots bind soils, while vegetation and litter trap most dislodged soil particles. Grass roots make up 50% of the plant mass.

2.2.4 Surface Area

There are two ways that large surface areas affect soil erodibility. First, they collect large volumes of water and the concentrated flows can be quite damaging. Second, the available supply of fugitive dust particles is increased. As a result of this problem with surface area, WSDOT has created standard specification 8-01.1, which limits acreage exposure based on time of year and location within Washington (Eastern/Western).

2.2.5 Slope Length & Gradient

Doubling the slope length increases the potential for water erosion four times and doubling the slope gradient increases the potential five times. With increased slope lengths and gradients, runoff travels faster with more erosive energy. Higher velocity runoff more rapidly form rills and gullies that concentrate erosive flows and energy even further.

2.2.6 Surface Texture

Increased surface texture decreases soil erosion by slowing runoff velocities and decreasing ground level wind speeds. Increased texture encourages infiltration of stormwater and reduces saltation and surface creep of wind blown soil particles.

2.3 TESC Planning & Implementation

2.3.1 Importance of Sufficient TESC Planning

Inadequate erosion control can lead to serious regulatory and economic setbacks to project delivery. WSDOT conducted a study to assess the costs of erosion control in the field. The study included a review of approximately 89 projects completed in 2001.
From that study, it was determined that 28 or approximately one-third of the projects were over budget for the line item water pollution prevention/erosion control. Only 18 projects, however, were responsible for the majority of cost overruns. The 18 projects were budgeted at $600,000 for water pollution prevention/erosion control, but a total of $2.6 million was spent. Those 18 projects were responsible for 80 percent of total erosion control spending for that year.

In an earlier study conducted on WSDOT projects from 1995-1999, a similar pattern emerged where very few projects were responsible for a majority of erosion control spending. Most of the projects experienced some form of site damage (90%) while progressively fewer encountered water quality violations (60%) and offsite damage to neighboring properties (40%).

Water quality and offsite damage virtually guarantee regulatory and/or legal involvement. If site damage can be avoided altogether, then it stands to reason that water quality violations and offsite damage can be avoided as well.

2.3.2 Purpose of a TESC Plan

Washington State Department of Transportation (WSDOT) requires Temporary Erosion and Sediment Control (TESC) plans on all construction projects that add or replace (removal of existing road surface down to base course) more than 2,000 square feet of impervious surface or disturb 7,000 square feet or more of soil. Projects that disturb less than 7,000 square feet of soil must address erosion control, but a stand-alone TESC plan is optional. An effective erosion control plan saves both time and money, and thus allows WSDOT to fulfill its responsibility to build highways in both fiscally and environmentally responsible manners.

The purpose of TESC planning is to clearly establish when, where, and how specific BMPs will be implemented to prevent erosion and the transport of sediment from a site during construction. TESC planning is used to identify potential problems and to provide solutions to eliminate or minimize the risk of erosion. It should indicate what BMPs will be implemented in the design of the project as well as the procedures used during construction to minimize erosion. Due to the unpredictable nature of weather and construction conditions, an erosion control plan must be flexible and open to modifications or additions during construction.

The principal focus of an effective TESC plan should be erosion control. Although every plan will contain both erosion and sediment control measures, it is more cost effective to emphasize erosion prevention. Erosion prevention should be considered in both the design and construction planning processes as well as during construction. Properly implemented erosion control BMPs prevent site damage and water quality problems that sediment control measures can at best only partially remedy.

2.3.3 Plan Elements

A WSDOT TESC plan includes two parts; a narrative (written description) section and a set of plan sheets. The narrative must be written first, as it is the tool used to analyze the factors affecting erodibility (see Section 2.2) and determine the correct combination of BMPs to apply. The narrative needs to account for intermediate stages of construction because the plan sheets only reveal temporary BMP placement for the built out condition of the project. It is necessary that all 12 Elements be considered during the planning process, although not all may be applicable. In that instance, simply state in the narrative why the element is not applicable. The TESC elements are:

- Element 1: Mark clearing limits
- Element 2: Establish construction access
- Element 3: Control flow rates
- Element 4: Install sediment controls
- Element 5: Stabilize soils
- Element 6: Protect slopes
- Element 7: Protect drain inlets
- Element 8: Stabilize channels and outlets
- Element 9: Control Pollutants
- Element 10: Control dewatering
- Element 11: Maintain BMPs
- Element 12: Manage the project

2.3.4 On-Line TESC Plan Template

A TESC plan template is available at WSDOT's Erosion Control Program website (http://www.wsdot.wa.gov/environment/wqec/erosion.htm). This template provides the most current information and contains text box descriptions at the beginning of each section that describe what information should be included for each TESC element. Examples of descriptive text, in italics, are also provided.

Each TESC element should be evaluated for risk and explained in as much detail as necessary. The evaluation must include all stages of project construction and account for varying seasons. After reviewing WSDOT's Standard Specifications and Standard Plans, determine if the Best Management Practices (BMPs) address the risks previously identified for the TESC elements. If a specification or plan does not adequately address the risk or is completely nonexistent, then you need to locate an existing General Special Provision that may suite your needs or even write a Special Provision (see Section 2.5). Without supplementing the contract with a Special, the risk cannot be appropriately addressed.

2.3.5 WSDOT Prepares Initial Plan

WSDOT prepares an initial erosion control plan for all projects involving soil disturbances. These plans are prepared in advance to satisfy permit requirements for project approval. Important TESC planning details cannot be included in the initial plan because the contractor frequently determines construction dates, methods and schedules.

2.3.6 Contractor Modifies Plan at Pre-construction Meeting

Because contractors determine the construction methods and schedule, contractors are encouraged to modify the TESC plan so that it is compatible with their construction plans. The contractor should prepare TESC plan modifications for presentation at the Pre-construction Meeting. Modifications should describe: 1) how the construction schedule will minimize site exposure to erosion, 2) how TESC BMP installation will correspond with the construction schedule, 3) how and where the proposed erosion and sediment control measures will stabilize disturbed soils, divert or store flows, and retain sediments throughout each phase of construction, 4) how and when the TESC measures will be replaced or converted into permanent stormwater management BMPs, and 5) the schedule and procedures for monitoring and maintaining the erosion and sediment control measures.

2.3.7 TESC Plan Implementation

The contractor must identify an ESC Lead at the pre-construction meeting and the Lead is responsible for implementing the TESC plan throughout construction. This includes installing and maintaining the BMPs, performing the BMP inspections, maintaining the TESC file with current plans and inspection reports, and working with the WSDOT Engineer. Implementing the plan often includes making modifications in the field and the ESC Lead must coordinate with the WSDOT Engineer to modify the plan as needed.

The WSDOT engineer or inspector will conduct frequent site inspections to confirm that the contractor is implementing the plan and that the plan is working effectively. The WSDOT inspector will walk the site with the TESC plan in hand to evaluate whether BMPs were installed as specified on the plan drawings. Inspections will be made on a regular basis to ensure that the site is always prepared for a storm. The inspector may use a tool such as the TESC Field Checklist to evaluate whether BMPs have been installed properly and are effective (see Table 2.3.6). It is also valuable to the ESC Lead to assess the effectiveness of the site BMPs, and record inspection details.

When the ESC Lead becomes aware of a problem on the site, the WSDOT Engineer must be notified. The WSDOT Engineer will determine if the problem warrants notifying the regulatory authorities.

Table 2.3.7 TESC Field Checklist

WSDOT – ESC Lead

Project Title: ______________________________

Contact # ______________________________

Project Location/Region: ______________________________

Name: ______________________________

Indicate whether or not the project is meeting the Minimum Requirements (if applicable) for erosion control.
If the project is not meeting any Requirements, indicate on back the corrective actions required/taken.

	Yes	No
1. Mark Clearing Limits	Yes	No
Are the limits of clearing and grading clearly marked with barrier fencing?		
2. Establish Construction Access	Yes	No
Is a stabilized construction entrance or wheel wash present and preventing track out?		
3. Control Flow Rates	Yes	No
Is there any stormwater leaving the site and does the discharge meet State Water Quality Standards?		
Is sediment being deposited on adjacent properties or waterways?		
If no, what is the turbidity of site discharge and of receiving water?		
4. Install Sediment Controls	Yes	No
Are detention ponds installed to trap sediment from site runoff?		
Are side slopes and outfalls of detention pond(s) stabilized?		
Are sediment trapping BMPs (sediment traps, check dams, silt fences, etc.) in place?		
5. Stabilize Soils	Yes	No
Are erodible soils stabilized? (seed, mulch, erosion blankets, plastic, construction entrance, etc.)		
6. Protect Slopes	Yes	No
Are exposed cut and/or fill slopes stabilized and protected from concentrated flows?		
If there are groundwater seeps or springs, are the appropriate BMPs in place to dewater them (pipe slope drains, interceptor swales, dewatering wells)?		
7. Protect Drain Inlets	Yes	No
Are all storm drains onsite being protected with functioning temporary inlet protection devices?		

8. Stabilize Channels and Outlets	Yes	No
Are temporary conveyance channels adequately stabilized?		
Are conveyance channel outlets adequately stabilized?		
Is the site discharge contributing to offsite erosion?		

9. Control Pollutants	Yes	No
Are pollutants, including construction materials handled and disposed of in a manner that does not cause contamination of stormwater?		

10. Control De-watering	Yes	No
Is the groundwater treated in a way that optimizes overall site water quality?		

11. Maintain BMPs	Yes	No
Have the temporary BMPs been removed in areas that are completely stabilized?		
Are BMPs adequately maintained?		

12. Manage the Project	Yes	No
Is the TESC plan on-site and easily obtainable?		
Are the Contractor and WSDOT Erosion Lead clearly identified in the TESC plan?		
Is the contractor completing weekly BMP inspection forms and keeping records?		

Problems/Corrective Actions:

2.4 Types of BMPs

There are three types of erosion prevention BMPs that must be considered in TESC planning: design, procedural, and physical. An effective erosion control plan will address each of these BMP types. BMP selection should be based on preventing erosion rather than the treatment of turbid runoff as the result of erosion.

2.4.1 Design BMPs

A project design that minimizes erosion risks results in reduced erosion complications during and after construction. All possible measures should be utilized to minimize clearing and grading which exposes the site to erosion. Projects should be designed to integrate existing land contours as much as possible and minimize the angle and lengths of slopes. Project drainage design should consider water generated both on and off of the site that can impact erosion potential.

2.4.2 Procedural BMPs

How and when a project is built can greatly affect the potential for erosion. Sequencing and scheduling are some of the most important aspects of erosion control planning. Construction sequencing should minimize the duration and extent of soil disturbance. Whenever possible, major soil disturbing activities should be done in phases to minimize exposed areas. Likewise, major grading operations should be limited to the dry season.

An effective schedule prevents the site from becoming overexposed to erosion risks. The construction schedule should tie the installation of erosion control BMPs to the order of land disturbing activities. The types of activities that should be included in the schedule are:

- Installation of perimeter control and detention BMPs prior to soil-disturbing activities
- Phasing and timing of clearing, grubbing, and grading
- Interim BMP strategies
- Installation of permanent BMPs and a description of how temporary BMPs have been coordinated with the development of permanent measures
- Erosion control inspection and maintenance schedule

2.4.3 Physical BMPs

Physical BMPs include all of the erosion and sediment control measures that are put in place after all possible design and procedural BMPs have been considered. Physical BMPs should be considered as a supplement to and not a replacement for the design and procedural BMPs. Examples are described in Section 3 of this manual, the *Highway Runoff Manual*, and the *Washington State Department of Ecology Stormwater Management Manual for Western Washington.*

Selection of the appropriate physical erosion control BMPs is a crucial component of TESC planning and implementation. Properly installed and maintained physical BMPs can greatly reduce erosion where design and procedural BMPs have been implemented. Conversely, physical BMPs alone cannot adequately prevent erosion or water quality violations if design or procedural BMPs are not employed. When multiple BMPs can be used to correct the same problem, consult Section 3 for more information on individual BMPs.

When selecting BMPs it is important to correctly identify the source of the problem. It is better to treat the source once than constantly battle with the symptoms down gradient; i.e., cover a slope once as opposed to fixing a silt fence ten times. Misidentification of the source of the problem often leads to wasting of time, material and money on inappropriate and ineffective measures.

2.5 Standard Specifications, General Special Provisions, & Standard Plans

The ability to enforce the TESC plan is directly tied to the contract. Contracts must be written to ensure TESC elements are addressed throughout construction. The contractual tools for ensuring this include the Standard Specifications, General Special Provisions (statewide and region specific), Special Provisions, and Standard Plans.

The Erosion Control Program works with the Construction Office and updates the Standard Specifications every 3-6 months. A complete electronic copy is available online at http://wwwi.wsdot.wa.gov/eesc/cons/pdfs/SS2004b.pdf. Standard Plans compliment Standard Specifications with details on installation requirements. Plans can be downloaded from the Design Office website at http://www.wsdot.wa.gov/eesc/design/designstandards/newstdplans.htm. However, when the erosion/sediment risk is so unique that a Standard Specification is not sufficient, either a General or Special Provision must be written.

Section 3

3.1 Introduction – Best Management Practices

This section covers Best Management Practices (BMPs) employed to prevent or reduce erosion on a construction site. There are three levels of BMPs including 1) design, 2) procedural, and 3) physical. Design and procedural BMP definitions and examples are covered in section 4 of this manual. Section 3 covers all of the physical BMPs.

Physical BMPs are organized into two parts; erosion control (preventing soil detachment) and sediment control (trapping detached soil particles). Temporary and permanent cover using natural or simulated vegetation are examples of source control BMPs. That is, they prevent erosion from happening in the first place. However, even the best efforts at preventing erosion are usually not 100% effective, particularly during big rain events. Sediment control BMPs such as silt fence work to remove as much sediment as possible from runoff before it leaves the site.

Properly installed erosion control BMPs improves the performance of sediment control efforts. However, solely relying on erosion control BMPs is inadequate. In addition, solely relying on sediment control without performing any erosion control will overwhelm the BMPs.

Many structural erosion control BMPs do not actually cover bare soil. They prevent further erosion by preventing existing runoff from accessing the soil. Other structural control BMPs prevent site conditions from getting worse as a result of construction activities.

All prefabricated erosion and sediment control BMPs must be approved prior to use on WSDOT projects. The Qualified Products Lists (QPL) contains many pre-approved products to choose from. Manufacturers of products must submit an application with specific product information to WSDOT's New Products Committee for review. Applications can be submitted online to the New Products Committee and the QPL can be viewed at the following website: http://www.wsdot.wa.gov/biz/mats/QPL/QPl.cfm

3.2 Temporary Cover

3.2.1 Temporary Seeding

Definition

The establishment of a temporary vegetative cover on disturbed areas by seeding with plants. Temporary soil stabilization is provided to areas that remain bare where permanent cover is not necessary or appropriate.

Purpose

A well-established vegetative cover is one of the most effective methods of reducing erosion by protecting bare soil from raindrop impact and binding the soil with its roots.

WSDOT Specification

2004 Standard Specifications
8-01.3(2) Temporary Seeding, Mulching, and Soil Binding

8-01.3(2)A Temporary Seeding
Temporary seeding is used to establish temporary cover on disturbed soil. Temporary seeding shall be in accordance with Section 8-02.

8-01.3(2)B Temporary Mulching
Temporary mulch, such as straw, wood cellulose (with and without tackifier), compost, or other best management practices as approved by the Engineer, may be applied at any time of the year for soil cover. Temporary mulching shall be in accordance with Section 8-02.3(15).

8-02.3(15) Erosion Control Seeding, Fertilizing, and Mulching

8-02.3(15)A Preparation For Final Application
Areas to be cultivated are shown in the Plans or specified in the Special Provisions. The areas shall be cultivated to the depths specified to provide a reasonably firm but friable seedbed. Cultivation shall take place no sooner than two weeks prior to seeding. All areas to be seeded, including excavated slopes shall be compacted and prepared unless otherwise specified or ordered by the Engineer. Unless seed is covered with soil immediately after seed application, a cleated roller, crawler tractor, or similar equipment, approved by the Engineer that forms longitudinal depressions at least 2 inches deep shall be used for compaction and preparation of the surface to be seeded. The entire area shall be uniformly covered with longitudinal depressions formed perpendicular to the natural flow of water on the slope unless

otherwise approved by the Engineer. The soil shall be conditioned with sufficient water so the longitudinal depressions remain in the soil surface until completion of the seeding. The area shall be compacted within three weeks prior to seeding. Prior to seeding, the finished grade of the soil shall be 1 inch, or the specified depth of mulch, below the top of all curbs, catch basins, junction and valve boxes, walks, driveways, and other structures.

8-02.3(15)B Seeding and Fertilizing
Seed and fertilizer shall be placed at the rate, mix and analysis specified in the Special Provisions or as designated by the Engineer. The Contractor shall notify the Engineer not less than 24 hours in advance of any seeding operation and shall not begin the work until areas prepared or designated for seeding have been approved. Following the Engineer's approval, seeding of the approved slopes shall begin immediately. Seeding shall not be done during windy weather or when the ground is frozen, excessively wet, or otherwise untillable. Seed and fertilizer may be sown by one of the following methods:

1. An approved hydro seeder that utilizes water as the carrying agent, and maintains continuous agitation through paddle blades. It shall have an operating capacity sufficient to agitate, suspend, and mix into a homogeneous slurry the specified amount of seed and water or other material. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles that will provide a uniform distribution of the slurry.

2. Approved blower equipment with an adjustable disseminating device capable of maintaining a constant, measured rate of material discharge that will ensure an even distribution of seed at the rates specified.

3. Helicopters properly equipped for aerial seeding.

4. Approved power-drawn drills or seeders.

5. Areas in which the above methods are impractical may be seeded by approved hand methods. When seeding by hand, the seed shall be incorporated into the top 1/4 inch of soil by hand raking or other method that is approved by the Engineer. The seed shall have a tracer added to visibly aid uniform application. This tracer shall not be harmful to plant and animal life. If wood cellulose fiber is used as a tracer, the application rate shall not exceed 250 pounds per acre. Hand seeding operations are excluded from this requirement. Seed and fertilizer may be applied in one application provided that the fertilizer is placed in the hydro seeder tank no more than one hour prior to application.

8-02.3(15)C Liming
Agricultural lime shall be applied at the rates specified in the Special Provisions. The method of application shall be in conformance with all air and water pollution regulations and shall be approved by the Engineer.

8-02.3(15)D Mulching
Mulch of the type specified in the Special Provisions shall be furnished, hauled, and evenly applied at the rates indicated and shall be spread on seeded areas within 48 hours after seeding unless otherwise specified. Distribution of straw mulch material shall be by means of an approved mulch spreader that utilizes forced air to blow mulch material on seeded areas. In spreading straw mulch, the spreader shall not cut or break the straw into short stalks. Wood cellulose fiber may be applied with seed and fertilizer West of the summit of the Cascade Range. East of the summit of the Cascade Range, seed and fertilizer shall be applied in one application followed by the application of wood cellulose fiber. Wood cellulose fiber used as mulch shall be suitable for application with a hydro seeder as specified in Section 8-02.3(15)B. Areas not accessible by mulching equipment shall be mulched by approved hand methods. Mulch sprayed on signs or sign structures shall be removed the same day.

8-02.3(15)E Soil Binder or Tacking Agent
When the proposal includes a pay item for soil binders and tacking agents, they shall be applied in accordance with the manufacturer's recommended requirements. Tackifiers used as a tie-down for seed and mulch shall be applied in quantities sufficient to equal the retention properties of guar when applied at the rate of 60 pounds per acre.

8-02.3(15)F Dates for Application of Final Seed, Fertilizer, and Mulch
Unless otherwise approved by the Engineer, the final application of seeding, fertilizing, and mulching of slopes shall be performed during the following periods:

West of the summit of the Cascade Range - March 1 to May 15 and August 15 to October 1. Where contract timing is appropriate, seeding, fertilizing, and mulching shall be accomplished during the fall period listed above. Written permission to seed after October 1 will only be given when physical completion of the project is imminent and the environmental conditions are conducive to satisfactory growth.

East of the summit of the Cascade Range - October 1 to November 15. Seeding, fertilizing, and mulching shall be accomplished during this fall period only.

8-02.3(15)G Protection and Care of Seeded Areas
In addition to the requirements of Section 1-07.13(1), the contractor shall be responsible for performing the following duties:

1. Protect all areas involved against vehicle and pedestrian traffic by use of approved warning signs and barricades.

2. Areas, which have been damaged through any cause prior to final inspection, and areas failing to receive a uniform application at the specified rate, shall be reseeded, refertilized, and remulched at the Contractor's expense.

3. Seeded areas within the planting area shall be considered part of the planting area. Weeds within the seeded areas shall be controlled in accordance with Section 8-02.3(3).

Additional Information

- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.2.

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3.2.2 Mulching

Definition

Application of organic material to protect bare soil from raindrop and sheet erosion, in addition to enhancing seed germination.

Purpose

Mulch provides immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures. There are numerous mulches that can be used, such as straw, wood chips (hog-fuel), wood fibers, and compost.

WSDOT Specification

2004 Standard Specifications
8-01.3(2)B Temporary Mulching
Temporary mulch, such as straw, wood cellulose (with and without tackifier), compost, or other best management practices as approved by the Engineer, may be applied at any time of the year for soil cover. Temporary mulching shall be in accordance with Section 8-02.3(15).

8-02.3(15)D Mulching
Mulch of the type specified in the Special Provisions shall be furnished, hauled, and evenly applied at the rates indicated and shall be spread on seeded areas within 48 hours after seeding unless otherwise specified. Distribution of straw mulch material shall be by means of an approved mulch spreader that utilizes forced air to blow mulch material on seeded areas. In spreading straw mulch, the spreader shall not cut or break the straw into short stalks. Wood cellulose fiber may be applied with seed and fertilizer West of the summit of the Cascade Range. East of the summit of the Cascade Range, seed and fertilizer shall be applied in one application followed by the application of wood cellulose fiber. Wood cellulose fiber used as mulch shall be suitable for application with a hydro seeder as specified in Section 8-

02.3(15)B. Areas not accessible by mulching equipment shall be mulched by approved hand methods. Mulch sprayed on signs or sign structures shall be removed the same day.

Additional Information

- Compost is a popular material for mulching due to soil amending properties that benefit plant growth and because of its significant stormwater infiltration capacity. Compost must be sufficiently aged or digested and meet the materials specification in Section 9-14.4(8) to prevent leaching of nutrients into the runoff.
- Wood chips left over from land clearing activities are also a great mulch. During the decomposition process, however, a nitrogen deficiency in the soil can occur making it difficult for plants to grow well.
- Wood chip mulch is also a suitable material for stabilizing entrances and haul roads.
- Hand spread straw is less likely to be displaced because of its weight and length. Blown straw is smaller and may be more susceptible to wind and rain action.
- Tackifiers ranging from organic to inorganic are available for use to prevent displacement by wind and rain (Refer to 8-01.3(2)C Soil Binding Using Polyacrylamide (PAM), and 8-02.3(15) Erosion Control Seeding, Fertilizing, and Mulching).
- Consult with the Engineer to determine which mulch is best for the project.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.2.

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3.2.3 Blankets and Mats

Definition

A blanket made of natural plant material or synthetic fibers, which is rolled out and fastened to the soil surface to protect soil from raindrop and sheet erosion.

Purpose

Erosion control blankets protect soil from raindrop and sheet erosion until permanent vegetation is established. Organic blankets are made of either jute, straw, wood shavings, coconut fiber (coir) or varying combinations of each. Product longevity ranges from six months to five years depending on composition of blanket and environmental conditions. Synthetic blankets often contain materials that resist ultraviolet light and last more than five years. While most are suitable for slopes, others can be used in ditches with considerable volumes/velocities.

WSDOT Specification

2004 Standard Specifications
8-01.3(3) Placing Erosion Control Blanket
When required, erosion control blanket shall be placed immediately following the seeding and fertilizing operation. Temporary erosion control blankets as defined in 9-14.5, having an open area of 60% or greater, may be installed prior to seeding.

Additional Information

Refer to WSDOT Products Database for more information on blanket types, features, and manufacturers.

Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.2.

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Figure 3.2.3A Erosion Control Blanket Placement On Slope

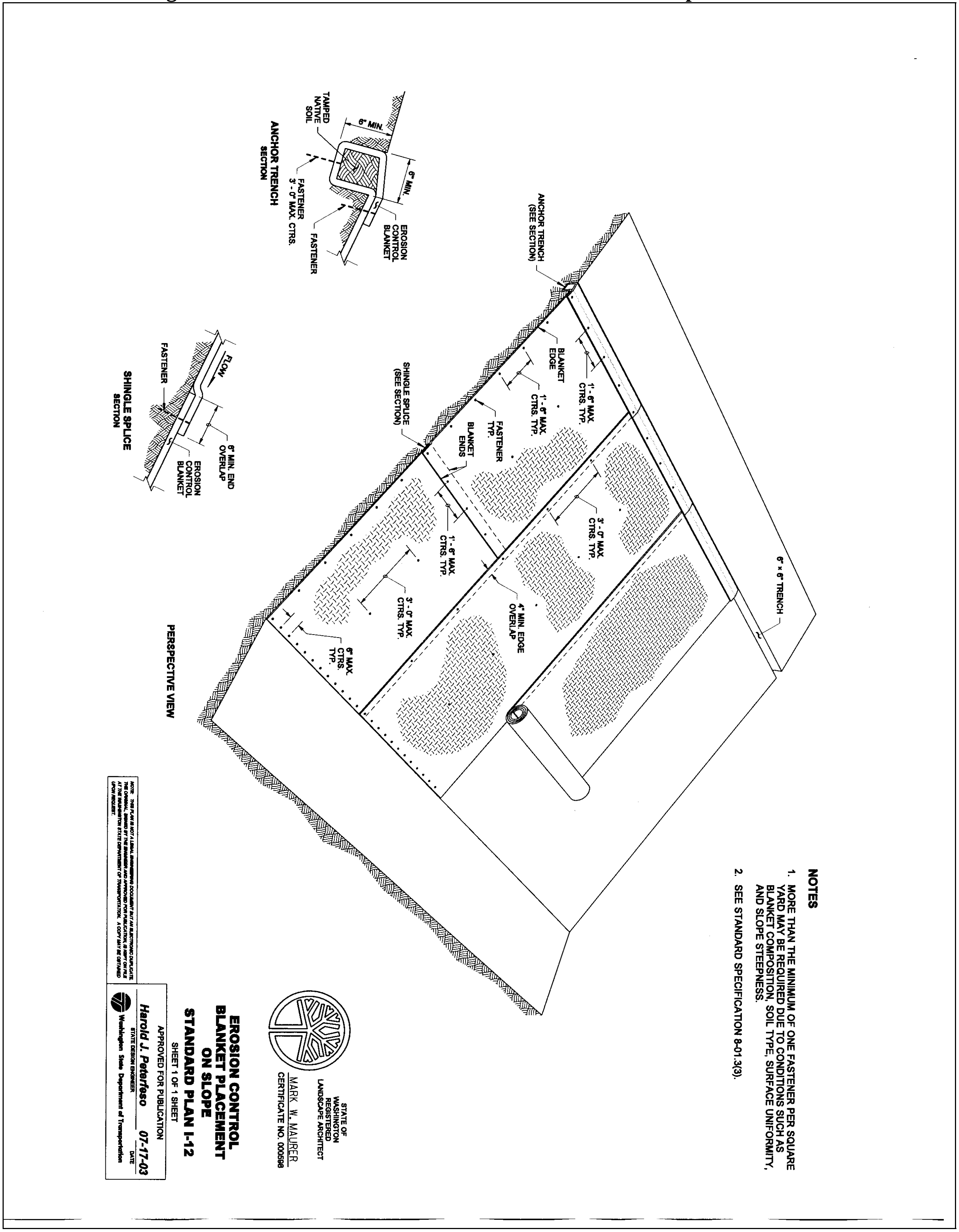
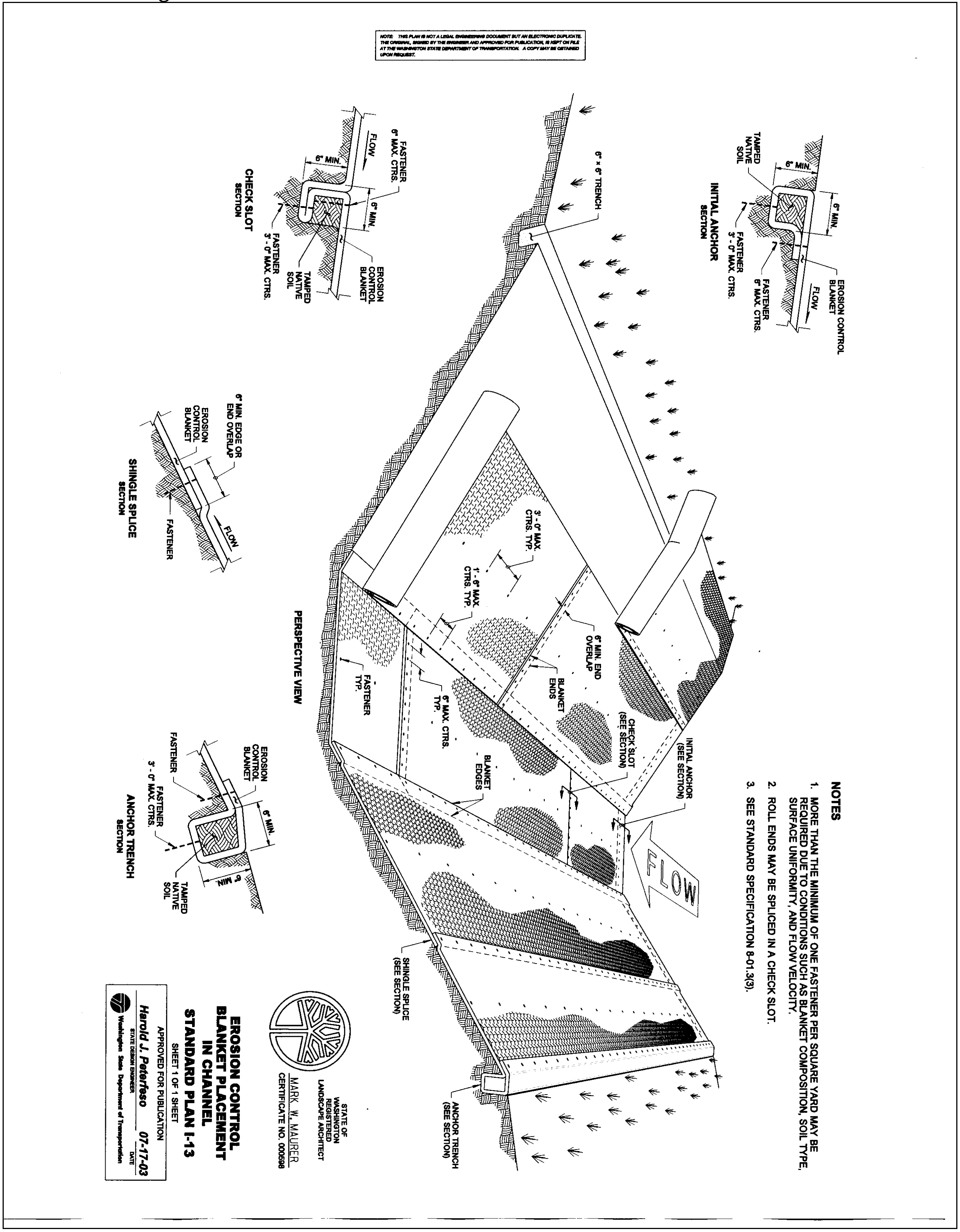


Figure 3.2.3B Erosion Control Blanket Placement In Channel



3.2.4 Plastic Covering

Definition

The covering of bare areas with plastic sheeting to provide immediate erosion protection.

Purpose

The three main uses for plastic include providing: (1) immediate coverage of slopes and stockpiles; (2) short term coverage where mulch or blankets are not an option; and (3) protection from extreme cold weather to encourage early growth of vegetation. WSDOT Specification

WSDOT Specification

2004 Standard Specifications
8-01.3(5) Placing Plastic Covering
Plastic meeting the requirements of Section 9-14.5(3) shall be placed with at least a 12-inch overlap of all seams. Clear plastic covering shall be used to promote growth of vegetation. Black plastic covering shall be used for stockpiles or other areas where vegetative growth is unwanted. The cover shall be maintained tightly in place by using sandbags on ropes in a 10-foot, maximum, grid. All seams shall be weighted down full length.

Additional Information

- Plastic provides 100% protection of the soil, however, it collects 100% of the rain and transfers the erosion potential elsewhere. Therefore, energy dissipation below the plastic, as well as conveyance of runoff should be anticipated.
- As with erosion blankets, plastic must be keyed in at the top of the slope to prevent water from going under the plastic and upslope sheets must be placed over down slope sheets like shingles on a roof.
- There is a belief that plastic is cheap and easy to use. This is not always the case. Data shows that the average cost per square yard of installed plastic is $1.90. When maintenance, removal, and disposal costs are added, a more accurate figure is $2.20 to $2.50 per square yard.
- By way of comparison, erosion blankets average $1.20 to $1.75 per square yard installed.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.2.

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3.2.5 Polyacrylamide for Soil Erosion Protection

Definition

PAM is a long-chain polymer developed to clarify drinking water that can be used in erosion control because of its ability to stabilize soils and remove fine suspended sediments from stormwater runoff at highway construction sites. PAM also increases infiltration rates in soils by preventing surface sealing.

Purpose

Applying PAM to bare soil in advance of a rain event reduces erosion and controls sediment. First, PAM binds soil particles together and reduces the affects of raindrop and sheet erosion. As a result, stormwater infiltration is increased because the soil pore volume is not clogged with fine sediments. Second, stormwater pond performance is enhanced because sediment that reaches the pond will contain PAM. The polymer binds the smaller particles together making longer, heavier particles that settle out of suspension faster than in the absence of PAM.

WSDOT Specification

2004 Standard Specifications
8-01.3(2)C Soil Binding Using Polyacrylamide (PAM)
The PAM shall be completely dissolved and mixed in water prior to being applied to the soil. PAM shall be applied only on bare soil at a rate of not more than 0.5 pounds per 1M gallons of water per acre. A minimum of 200 pounds per acre of cellulose fiber mulch treated with a non-toxic dye shall be applied with the PAM. PAM shall be applied only to areas that drain to completed sedimentation control BMPs in accordance with the TESC plan. PAM shall not be applied to the same area more than once in a 48 hour period, or more than 7 times in a 30 day period. PAM shall not be applied during a rain or to saturated soils.

Additional Information

- PAM products shall meet ANSI/NSF Standard 60 for drinking water treatment. PAM shall be “anionic” (non-ionic) and linear (non-crosslinked). The minimum average molecular weight shall be 5 Mg/mole.
- PAM shall not be directly applied to water or allowed to enter a water body.
- In areas that drain to a sediment pond, PAM can be applied to bare soil under the following conditions:
  - During rough grading operations
  - Staging areas.
  - Balanced cut and fill earthwork.
  - Haul roads prior to placement of crushed rock surfacing.
  - Compacted soil road base.
  - Stockpiles.
  - After final grade and before paving or final seeding and planting.
  - Pit sites.

- For sites having a winter shut down, or where soil will remain un-worked for several months, PAM should be used in combination with mulch.
- For small areas that need coverage, PAM can be applied at the dry application rate of 5 lbs/acre using a hand-held "organ grinder" seed spreader.
- Depending on site conditions, PAM will last 3 to 6 months in the soil from the date of application. Extreme weather and heavy traffic (if used on haul roads) will shorten the lifespan and will require more frequent application.
- Refer to the Washington State Department of Ecology's *Stormwater Management Manual for Western Washington, Volume II* for more information on PAM.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.2.

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WSDOT Standard Specification for Maintenance

2004 Standard Specifications
8-01.3(15) Maintenance
Erosion control devices shall be maintained so they properly perform their function until the Engineer determines they are no longer needed. The devices shall be inspected on the schedule outlined in Section 8-01.3(1)B for damage and sediment deposits. Damage to or undercutting of the device shall be repaired immediately.

3.3 Permanent Cover

3.3.1 Preserving Natural Vegetation

Definition

Minimizing exposed soils by clearing only where construction will occur.

Purpose

Vegetation provides the following benefits: (1) rainfall impact (energy) absorption; (2) reduction of runoff volumes and velocities; (3) sediment trapping; and (4) root stabilization of soil. Preserving natural vegetation reduces the need to spend money on BMPs, which try to mimic these natural benefits.

WSDOT Specification

2004 Standard Specifications
1-07.16(2) Vegetation Protection and Restoration
Existing vegetation, where shown in the Plans or designated by the Engineer, shall be saved and protected through the life of the contract. The Engineer will designate the vegetation to be saved and protected by a site preservation line and/or individual flagging. Damage which may require replacement of vegetation includes bark stripping, broken branches, exposed root systems, cut root systems, poisoned root systems, compaction of surface soil and roots, puncture wounds, drastic reduction of surface roots or leaf canopy, changes in grade greater than 6 inches, or any other changes to the location that may jeopardize the survival or health of the vegetation to be preserved.

When large roots of trees designated to be saved are exposed by the Contractor's operation, they shall be wrapped with heavy burlap for protection and to prevent excessive drying. The burlap shall be kept moist and securely fastened until the roots are covered to finish grade. All burlap and fastening material shall be removed from the roots before covering. All roots 1 inch or smaller in diameter, which are damaged, shall be pruned with a sharp saw or pruning shear. Damaged, torn, or ripped bark shall be removed as directed by the Engineer. If due to, or for any reason related to the Contractor's operation, any tree, shrub, ground cover or herbaceous vegetation designated to be saved is destroyed, disfigured, or damaged to the extent that continued life is questionable as determined by the Engineer, it shall be removed by the Contractor at the direction of the Engineer.

The Contractor will be assessed damages equal to triple the value of the vegetation as determined in the *Guide for Plant Appraisal*, Eighth Edition, published by the International Society of Arboriculture or the estimated cost of restoration with a similar species. Shrub, ground cover, and herbaceous plant values will be determined using the Cost of Cure Method. Any damage so assessed will be deducted from the monies due or that may become due the Contractor.

Additional Information

Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.3.

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3.3.2 Permanent Seeding and Planting

Definition

The establishment of perennial vegetative cover on disturbed areas. Species are often native to the region.

Purpose

To prevent soil erosion by wind or water, and to improve wildlife habitat and site aesthetics.

WSDOT Specification

2004 Standard Specifications

8-02.3(15)A Preparation For Final Application

Areas to be cultivated are shown in the Plans or specified in the Special Provisions. The areas shall be cultivated to the depths specified to provide a reasonably firm but friable seedbed. Cultivation shall take place no sooner than two weeks prior to seeding. All areas to be seeded, including excavated slopes shall be compacted and prepared unless otherwise specified or ordered by the Engineer. Unless seed is covered with soil immediately after seed application, a cleated roller, crawler tractor, or similar equipment, approved by the Engineer that forms longitudinal depressions at least 2 inches deep shall be used for compaction and preparation of the surface to be seeded. The entire area shall be uniformly covered with longitudinal depressions formed perpendicular to the natural flow of water on the slope unless otherwise approved by the Engineer. The soil shall be conditioned with sufficient water so the longitudinal depressions remain in the soil surface until completion of the seeding. The area shall be compacted within three weeks prior to seeding. Prior to seeding, the finished grade of the soil shall be 1 inch, or the specified depth of mulch, below the top of all curbs, catch basins, junction and valve boxes, walks, driveways, and other structures.

8-02.3(15)B Seeding and Fertilizing

Seed and fertilizer shall be placed at the rate, mix and analysis specified in the Special Provisions or as designated by the Engineer. The Contractor shall notify the Engineer not less than 24 hours in advance of any seeding operation and shall not begin the work until areas prepared or designated for seeding have been approved. Following the Engineer's approval, seeding of the approved slopes shall begin immediately. Seeding shall not be done during windy weather or when the ground is frozen, excessively wet, or otherwise untillable. Seed and fertilizer may be sown by one of the following methods:

1. An approved hydro seeder that utilizes water as the carrying agent, and maintains continuous agitation through paddle blades. It shall have an operating capacity sufficient to agitate, suspend, and mix into a homogeneous

slurry the specified amount of seed and water or other material. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles that will provide a uniform distribution of the slurry.

2. Approved blower equipment with an adjustable disseminating device capable of maintaining a constant, measured rate of material discharge that will ensure an even distribution of seed at the rates specified.

3. Helicopters properly equipped for aerial seeding.

4. Approved power-drawn drills or seeders.

5. Areas in which the above methods are impractical may be seeded by approved hand methods. When seeding by hand, the seed shall be incorporated into the top 1/4 inch of soil by hand raking or other method that is approved by the Engineer. The seed shall have a tracer added to visibly aid uniform application. This tracer shall not be harmful to plant and animal life. If wood cellulose fiber is used as a tracer, the application rate shall not exceed 250 pounds per acre. Hand seeding operations are excluded from this requirement. Seed and fertilizer may be applied in one application provided that the fertilizer is placed in the hydro seeder tank no more than one hour prior to application.

8-02.3(15)C Liming
Agricultural lime shall be applied at the rates specified in the Special Provisions. The method of application shall be in conformance with all air and water pollution regulations and shall be approved by the Engineer.

8-02.3(15)D Mulching
Mulch of the type specified in the Special Provisions shall be furnished, hauled, and evenly applied at the rates indicated and shall be spread on seeded areas within 48 hours after seeding unless otherwise specified. Distribution of straw mulch material shall be by means of an approved mulch spreader that utilizes forced air to blow mulch material on seeded areas. In spreading straw mulch, the spreader shall not cut or break the straw into short stalks. Wood cellulose fiber may be applied with seed and fertilizer West of the summit of the Cascade Range. East of the summit of the Cascade Range, seed and fertilizer shall be applied in one application followed by the application of wood cellulose fiber. Wood cellulose fiber used as mulch shall be suitable for application with a hydro seeder as specified in Section 8-02.3(15)B. Areas not accessible by mulching equipment shall be mulched by approved hand methods. Mulch sprayed on signs or sign structures shall be removed the same day.

8-02.3(15)E Soil Binder or Tacking Agent
When the proposal includes a pay item for soil binders and tacking agents, they shall be applied in accordance with the manufacturer's recommended requirements. Tackifiers used as a tie-down for seed and mulch shall be applied in quantities sufficient to equal the retention properties of guar when applied at the rate of 60 pounds per acre.

8-02.3(15)F Dates for Application of Final Seed, Fertilizer, and Mulch
Unless otherwise approved by the Engineer, the final application of seeding, fertilizing, and mulching of slopes shall be performed during the following periods:

West of the summit of the Cascade Range - March 1 to May 15 and August 15 to October 1. Where contract timing is appropriate, seeding, fertilizing, and mulching shall be accomplished during the fall period listed above. Written permission to seed after October 1 will only be given when physical completion of the project is imminent and the environmental conditions are conducive to satisfactory growth.

East of the summit of the Cascade Range - October 1 to November 15. Seeding, fertilizing, and mulching shall be accomplished during this fall period only.

8-02.3(15)G Protection and Care of Seeded Areas
In addition to the requirements of Section 1-07.13(1), the contractor shall be responsible for performing the following duties:

1. Protect all areas involved against vehicle and pedestrian traffic by use of approved warning signs and barricades.

2. Areas, which have been damaged through any cause prior to final inspection, and areas failing to receive a uniform application at the specified rate, shall be reseeded, refertilized, and remulched at the Contractor's expense.

3. Seeded areas within the planting area shall be considered part of the planting area. Weeds within the seeded areas shall be controlled in accordance with Section 8-02.3(3).

Additional Information

- Refer to section 3.1.1, Temporary Seeding, for various seed mixes.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.3.

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3.3.3 Sodding

Definition

Stabilizing fine-graded disturbed areas by establishing permanent grass stands with sod.

Purpose

To establish permanent turf for immediate erosion protection or to stabilize drainage ways where concentrated overland flow will occur.

WSDOT Specification

2004 Standard Specifications
9-14.6(8) Sod
The available grass mixtures on the current market shall be submitted to the Engineer for selection and approval. The sod shall be field grown one calendar year or older, have a well developed root structure, and be free of all weeds, disease, and insect damage. Prior to cutting, the sod shall be green, in an active and vigorous state of growth, and mowed to a height not exceeding 1 inch. The sod shall be cut with a minimum of 1 inch of soil adhering.

Additional Information

- Sod may be more expensive than other permanent cover BMPs but because the grass is already established, instant protection is provided.
- In swales, placing sod strips perpendicular to the flow of water increases its ability to resist shear stress.
- Staggering sod strips will produce a tight fit.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.3.

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3.3.4 Topsoiling

Definition

Preserving or importing topsoil to promote vegetation establishment in nutrient-poor soils.

Purpose

To provide a suitable growth medium for final site stabilization.

WSDOT Specification

2004 Standard Specifications Page 8-13
8-02.3(4) Topsoil
Topsoil shall be evenly spread over the specified areas to the depth shown in the Plans or as otherwise ordered by the Engineer. The soil shall be cultivated to a depth of 1 foot or as specified in the Special Provisions or the Plans. After the topsoil has been spread, all large clods, hard lumps, and rocks 3 inches in diameter and larger, and litter shall be raked up, removed, and disposed of by the Contractor. Topsoil shall not be placed when the ground or topsoil is frozen, excessively wet, or in the opinion of the Engineer in a condition detrimental to the work.

8-02.3(4)A Topsoil Type A
Topsoil Type A shall be as specified in the Special Provisions.

8-02.3(4)B Topsoil Type B
Topsoil Type B shall be native topsoil taken from within the project limits and shall meet the requirements of Section 9-14.1(2). Topsoil Type B shall be taken from areas designated by the Engineer to the designated depth and stockpiled at locations that will not interfere with the construction of the project, as approved by the Engineer. Areas beyond the slope stakes shall be disturbed as little as possible in the above operations. When topsoil Type B is specified, it shall be the Contractor's responsibility to perform the excavation operations in such a manner that sufficient material is set aside to satisfy the needs of the project. Upon physical completion of the work, topsoil Type B remaining and not required for use on the project shall be disposed of by the Contractor at no expense to the Contracting Agency and to the satisfaction of the Engineer. Should a shortage of topsoil Type B occur, and the Contractor has wasted or otherwise disposed of topsoil material, the Contractor shall furnish topsoil Type C at no expense to the Contracting Agency. Topsoil Type B will not be considered as selected material, as defined in Section 2- 03.3(10), and the conditions of said section shall not apply. Materials taken from roadway excavation, borrow, stripping, or other excavation items, and utilized for topsoil, will not be deducted from the pay quantities for the respective items.

8-02.3(4)C Topsoil Type C
Topsoil Type C shall be native topsoil obtained from a source provided by the Contractor outside of the Contracting Agency-owned right of way. Topsoil Type C shall meet the requirements of Section 8-02.3(4)B and Section 9-14.1(2).

Additional Information

Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.3.

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3.3.5 Conveyance Channel Stabilization

Definition

Conveyance channels move water and are categorized as flexible and rigid. Flexible include vegetation, blankets, gravel, and small-medium sized riprap. Rigid include pvc/concrete pipe, asphalt, and large rock.

Purpose

Conveyance channels are used to convey water from a project to a stable location capable of handling a given volume of water without causing erosion.

WSDOT Specification

No WSDOT Standard Specification exists; therefore, a special provision must be written.

Additional Information

The following general guidance comes from the Hydraulic Engineering Circular No. 15 – Design of Roadside Channels with Flexible Linings, Federal Highways Department publication (No. FHWA-IP-87-7).

The following principles must be considered when designing stable channels:

- Size channels to convey expected flows. Instructions on how to calculate peak runoff rates are provided in *Highway Runoff Manual*.
- Bare soil has very little resistance to erosion when subjected to concentrated flows. Channels must be armored to withstand expected erosive forces.
- Limit flow velocities if necessary to prevent damage to channel liners.
- Flexible liners are not as strong as rigid liners but are able to conform to changes in channel shape while maintaining the overall lining integrity. As a general guideline only rigid liners should be used in channels with shear stresses exceeding 8 lb/ft^2 or on slopes exceeding 10% (unless using properly sized riprap). Table 3.2.6A summarizes the advantages and disadvantages of the two liner types.

Table 3.2.6A Flexible Versus Rigid Lined Conveyances

Flexible	Rigid
Advantages • Inexpensive to install and maintain (grass lined ditches are self-healing) • Provide water quality treatment • Allow some infiltration • Cause less increase in peak flows	**Advantages** • Maximizes conveyance capacity using limited space • Fully effective immediately (no need to wait for grass to grow) • Can be designed to withstand and level of shear stress.
Disadvantages • Excessive flows can cause erosion • Vegetation requires time to become established • Requires more space • Not be used in channels where shear stress exceeds 8 lb/ft 2 or slopes exceeding 10% (except riprap)	**Disadvantages** • Expensive to build, maintain and repair • Increased peak discharge rates more likely to cause downstream erosion • No infiltration • No water quality treatment

The potential for erosion is based on shear stress, which is the force required to pull or peel (erode) material off of the bottom or sides of a ditch. Shear stress can be calculated using the following formula.

Shear Stress = WHG where:

W = Weight of water (62.4 lb/ft^3)
H = Height of water in feet
G = Channel gradient in ft/ft
(Channel gradient and water height in this formula assume an unobstructed flow of water in the ditch.)

Sample Shear Stress Calculation:

What is the shear stress in a straight ditch with a slope of 5% when the water is 1 foot deep?

Shear stress = (62.4 lb/ft^3)(1 ft)(.05) = 3.1 lb/ft^2

Using shear stress to determine effective liner types:

Table 3.2.6B indicates the maximum shear stresses that several different types of flexible liner materials can withstand. As a general guideline, multiply the expected maximum shear stress by 3 (a 30% safety factor is built in) to the diameter or riprap needed to stabilize a ditch. Manufacturers provide the shear strength ratings for erosion control blankets. Selection of liner material should be based upon the maximum shear stress that products or specified rock sizes can withstand.

Sample Calculation and Product Selection Process:

What flexible liner materials are adequate to stabilize a ditch with a 3% slope and an expected flow depth of 1.5 feet.

Shear stress = (62.4 lb/ft^3)(1.5 ft)(.03) = 2.81 lb/ft^2

If rock were used a minimum mean stone size of at least 8.4 inches should be used because (2.81) (3.0 conversion factor) = 8.4

Numerous coir erosion control blankets and synthetic turf reinforcement products could be substituted for rock with potentially significant cost savings. A well-established healthy stand of grass could also withstand the expected shear stresses in the ditch and help purify the runoff.

Table 3.2.6B Maximum Permissible Shear Stresses for Flexible Liners

Liner Category	Liner Type	Permissible Shear Stress (lbs/ft^2)
Bare soil - No liner	Non-cohesive soil Cohesive soil	0.01-0.04 up to 0.1 (non-compacted) up to 0.8 (compacted)
Erosion control blankets (Temporary / Permanent)*	Jute Curlex wood or straw Coir Organic, synthetic, or mix	0.45-1.0 1.0-2.5 2.0-4.0 10.0-12.0
Vegetative**	Uncut stand Cut grass	2.1-3.7 0.6-1.0
Gravel/riprap	1-inch 2-inch 6-inch 12-inch	0.33 0.67 2.0 4.0

* Permissible shear stresses based on products chosen at random to give a general idea of blanket strengths by material type. This table does not reflect the full range of permissible shear stresses for each product type.

** Varies with type and density of grass stand.

- Check dams can greatly reduce the velocity of flowing water, thereby reducing shear stress. Check dams can prevent erosion until the permanent grass liner is established. Temporary slope drains provide rigid lined conveyances until the permanent rigid or flexible lined channels are completed.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.3.

Notes ____

WSDOT Standard Specification for Maintenance

2004 Standard Specifications

8-01.3(15) Maintenance

Erosion control devices shall be maintained so they properly perform their function until the Engineer determines they are no longer needed. The devices shall be inspected on the schedule outlined in Section 8-01.3(1)B for damage and sediment deposits. Damage to or undercutting of the device shall be repaired immediately.

3.4 Structural Erosion Control

3.4.1 Fencing

Definition

Installing a physical barrier to define a project boundary or protect a sensitive feature.

Purpose

Fencing restricts clearing to approved limits, prevents disturbance of sensitive areas, and limits construction traffic to designated roads and entrances.

WSDOT Specification

No WSDOT Standard Specification exists for other fencing materials; therefore, a special provision must be written.

Additional Information

- Fencing is used to meet minimum requirements 2 and 3 of a TESC plan.
- Suitable fencing materials include plastic safety fence, metal fence, and silt fence. Silt fence is appropriate in areas where there is a concern of turbid runoff leaving the site. However, safety fence and other material should always be considered in place of silt fence where there is no concern of runoff.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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3.4.2 Stabilized Construction Entrance

Definition

A temporary stone-stabilized pad located at points of vehicular ingress and egress on a construction site.

Purpose

To reduce the amount of mud, dirt, rocks, etc., transported onto public roads by motor vehicles or runoff by constructing a stabilized pad of rock spalls at entrances to construction sites.

WSDOT Specification

2004 Standard Specifications
8-01.3(7) Stabilized Construction Entrance
Temporary stabilized construction entrance shall be constructed in accordance with the Plans, prior to beginning any clearing, grubbing, earthwork or excavation. When the stabilized entrance no longer prevents track out of sediment or debris, the Contractor shall either rehabilitate the existing entrance to original condition, or construct a new entrance. When the contract requires a tire wash in conjunction with the stabilized entrance, the Contractor shall include details for the tire wash and the method for containing and treating the sediment-laden runoff as part of the erosion control plan. All vehicles leaving the site shall stop and wash sediment from their tires.

Additional Information

- The same practice can be implemented for all staging and employee parking areas for the project.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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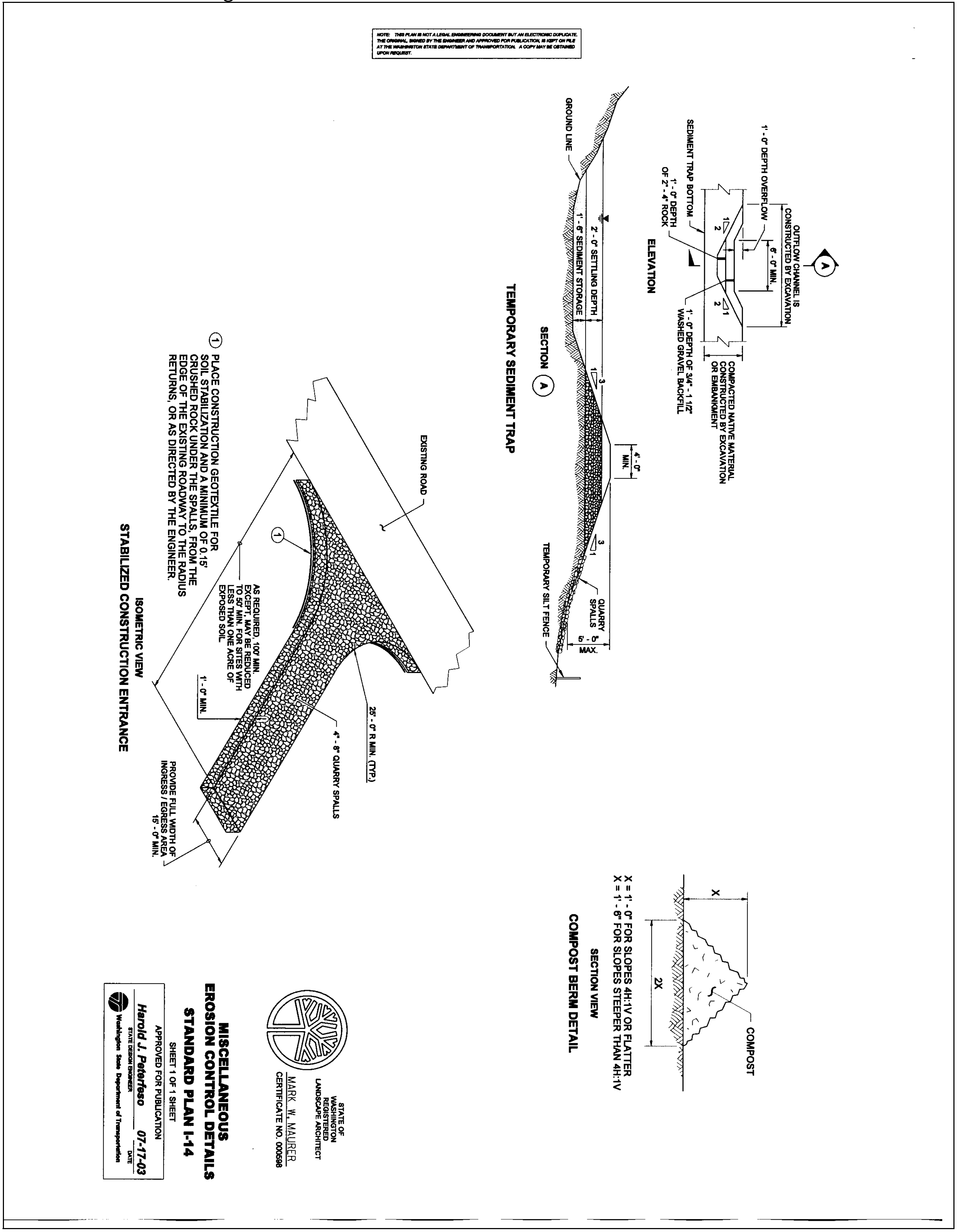
Figure 3.4.2 Stabilized Construction Entrance



3.4.3 Tire Wash

Definition

A system using a sump and spray equipment to remove sediment from vehicles during egress.

Purpose

A tire wash is used when a stabilized construction entrance does not prevent sediment from being tracked onto pavement.

WSDOT Specification

2004 Standard Specifications
8-01.3(7) Stabilized Construction Entrance
Temporary stabilized construction entrance shall be constructed in accordance with the Plans, prior to beginning any clearing, grubbing, earthwork or excavation. When the stabilized entrance no longer prevents track out of sediment or debris, the Contractor shall either rehabilitate the existing entrance to original condition, or construct a new entrance. When the contract requires a tire wash in conjunction with the stabilized entrance, the Contractor shall include details for the tire wash and the method for containing and treating the sediment-laden runoff as part of the erosion control plan. All vehicles leaving the site shall stop and wash sediment from their tires.

Additional Information

- Effective function requires participation by and communication with vehicle drivers.
- Wash water should be disposed of in a way that does not violate water quality standards.
- Local jurisdictions may require a tire wash as a permit condition.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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3.4.4 Construction Road Stabilization

Definition

The temporary stabilization of access roads and other on-site vehicle transportation routes immediately after grading.

Purpose

To reduce dust generation during dry weather and erosion of temporary roadbeds by construction traffic during wet weather and to eliminate the need for regrading of permanent roadbeds between the time of initial grading and final stabilization.

WSDOT Specification

No WSDOT Standard Specification exists; therefore, a special provision must be written.

Additional Information

- If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade.
- On areas that will receive asphalt as part of the project, install the first lift as soon as possible.
- A 6-inch depth of 2- to 4-inch crushed rock, gravel base, or crushed surfacing base course can be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. It may also be possible to use cement or calcium chloride for soil stabilization. If cement or cement kiln dust is used for road base stabilization, pH monitoring and BMPs are necessary to evaluate and minimize the effects on stormwater.
- Roadways shall be carefully graded to drain. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches should be directed to a sediment control BMP.
- Rather than relying on ditches, it may also be possible to grade the road so that runoff sheet-flows into a heavily vegetated area with a well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation, then it is generally preferable to use the vegetation to treat runoff, rather than a sediment pond or trap.
- Project storm drain inlets shall be protected to prevent sediment-laden water entering the storm drain system.
- Inspect stabilized areas regularly, especially after large storm events.
- Crushed rock, gravel base, hog fuel, etc. shall be added as required to maintain a stable driving surface and to stabilize any areas that have eroded.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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3.4.5 Dust Control

Definition

Reducing surface and air movement of dust during land disturbing, demolition, and construction activities.

Purpose

To prevent surface and air movement of dust where on-site and off-site impacts to roadways, drainage ways, or surface waters are likely.

WSDOT Specification

No WSDOT Standard Specification exists; therefore, a special provision must be written.
Additional Information

- Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.
- Limit dust generation by clearing only those areas where immediate activity will take place.
- Construct natural or artificial windbreaks or windscreens.
- Spray the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance.
- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM.

Techniques that can be used for unpaved roads and lots include:

- Lower speed limits.
- Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials.
- Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those passing a #200 screen) to 10 to 20 percent.
- Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction.
- Encourage the use of alternate, paved routes, if available.
- Restrict use by tracked vehicles and heavy trucks to prevent damage to road surface and base.
- Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.
- Pave unpaved permanent roads and other high-traffic areas.
- Use vacuum street sweepers.

- Remove mud and other dirt promptly so it does not dry and then turn into dust.
- Limit dust-causing work on windy days.

Contact your local Air Pollution Control Authority for guidance and training on other dust control measures. Compliance with the local Air Pollution Control Authority constitutes compliance with this BMP.

Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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3.4.6 Surface Roughening

Definition

Creating longitudinal depressions perpendicular to the natural flow of runoff by using a cleated roller, crawler tractor, or similar equipment.

Purpose

To aid in the establishment of vegetative cover by reducing runoff velocity, increasing infiltration, and providing for sediment trapping.

WSDOT Specification

2004 Standard Specifications
8-02.3(15)A Preparation For Final Application
Areas to be cultivated are shown in the Plans or specified in the Special Provisions. The areas shall be cultivated to the depths specified to provide a reasonably firm but friable seedbed. Cultivation shall take place no sooner than two weeks prior to seeding. All areas to be seeded, including excavated slopes shall be compacted and prepared unless otherwise specified or ordered by the Engineer. Unless seed is covered with soil immediately after seed application, a cleated roller, crawler tractor, or similar equipment, approved by the Engineer that forms longitudinal depressions at least 2 inches deep shall be used for compaction and preparation of the surface to be seeded. The entire area shall be uniformly covered with longitudinal depressions formed perpendicular to the natural flow of water on the slope unless otherwise approved by the Engineer. The soil shall be conditioned with sufficient water so the longitudinal depressions remain in the soil surface until completion of the seeding. The area shall be compacted within three weeks prior to seeding. Prior to seeding, the finished grade of the soil shall be 1 inch, or the specified depth of mulch, below the top of all curbs, catch basins, junction and valve boxes, walks, driveways, and other structures.

Additional Information

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, contour furrows, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

- Disturbed areas that will not require mowing may be stair-step graded, grooved, or left rough after filling.

- Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material that sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment. Stair steps must be on contour or gullies will form on the slope.
- Areas that will be mowed (these areas should have slopes less steep than 3:1) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.
- Graded areas with slopes greater than 3:1 but less than 2:1 should be roughened before seeding. This can be accomplished in a variety of ways, including "track walking," or driving a crawler tractor up and down the slope, leaving a pattern of cleat imprints parallel to slope contours.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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3.4.7 Temporary Pipe Slope Drains

Definition

A pipe extending from the top to the bottom of a cut or fill slope and discharging into a stabilized conveyance, sediment-trapping device, or stabilized outfall.

Purpose

To carry concentrated runoff down slopes without causing rills and gullies and to minimize saturation of slide-prone soils.

WSDOT Specification

2004 Standard Specifications

8- 01.3(14) Temporary Pipe Slope Drain

Pipe slope drain shall be constructed in accordance with the Plans and shall meet the requirements of Section 9-05.1(6). Water Interceptor dikes or temporary curbs shall be used to direct water into pipe slope drain. Entrance to drain may consist of prefabricated funnel device specifically designed for application, rock, sand bags, or as approved. The soil around and under the pipe section(s) shall be thoroughly compacted to prevent undercutting. Pipe shall be securely fastened together and have gasketed watertight fittings, and secured to the slope with metal “T” posts, wood stakes, sand bags, or as approved. Discharge the water to a stabilized conveyance, sediment trap, stormwater pond, rock splash pad, vegetated strip, or as approved. Placement of drain shall not pond water on road surface and create a road hazard to vehicles or pedestrians.

Additional Information

- The *Highway Runoff Manual* provides information for the calculation of flow rates and selection of pipe diameters large enough to convey the flow
- Pipe slope drains can be used when a temporary or permanent stormwater conveyance is needed to move the water down a slope to prevent erosion.

- On highway projects, they can be used at bridge ends to collect runoff and pipe it to the base of the fill slopes along bridge approaches. These can be designed into a project and included as bid items. Another use on road projects is to collect runoff from pavement and pipe it away from side slopes. These are useful because there is generally a time lag between having the first lift of asphalt installed and the curbs, gutters, and permanent drainage installed.
- Water can be collected and channeled to inlets with sand bags, triangular silt dikes, berms, or other material, and piped to temporary sediment ponds, vegetated strips, and infiltration areas.
- Use temporary drains on new cut or fill slopes.
- Compact the soil around and under the pipe and entrance section to prevent undercutting.
- Securely connect the flared inlet section to the slope drain.
- Securely fasten multiple slope drain sections together or use gasketed watertight fittings.
- If 90 degree bends cannot be avoided, install thrust blocks constructed from sandbags, straw bales staked in place, “t” posts and wire, or ecology blocks.
- Secure pipe along its full length to prevent movement. This can be done with steel “t” posts and wire. A post is installed on each side of the pipe and the pipe is wired to them. This should be done every 10-20 feet of pipe length or so, depending on the size of the pipe and quantity of water to diverted.
- Pipe slope drains can be used to convey water collected by interceptor dikes. Ensure that the height of the dike be at least 1 foot higher at all points than the top of the inlet pipe.
- The area below the outlet must be stabilized with a riprap apron.
- If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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3.4.8 Temporary Curb

Definition

Curb installed at top of slope to convey water to stabilized conveyances, thereby preventing erosion on cut and fill slopes.

Purpose

To direct concentrated runoff to stabilized conveyances such as pipe slope drains in order to avoid rills and gullies and to minimize saturation of slide-prone soils.

WSDOT Specification

2004 Standard Specifications
8-01.3(13) Temporary Curb
Temporary curbs may consist of asphalt, concrete, sand bags, compost socks, wattles, or geotextile/plastic encased berms of soil, , sand or gravel, or as approved by the Engineer.
Temporary curbs shall be installed along pavement edges to prevent runoff from flowing onto erodible slopes. The redirected water shall flow to a BMP designed to convey concentrated runoff. The temporary curbs shall be 4 inches in height.

Additional Information

- Do not leave gaps in temporary curb without stabilized conveyance. Gaps left in curb will cause more severe gully erosion than if the curb wasn't there in the first place.
- When connecting pipe to curb, arrange curb material, such as sandbags or asphalt to form sump to minimize bypass of the pipe.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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3.4.9 Concrete Handling

Definition

To minimize and eliminate concrete process water from entering waters of the state.

Purpose

Reduce the impact to regulated water bodies resulting from concrete work including sawing, grinding, and resurfacing. Turbidity and pH are parameters impacted by concrete work.

WSDOT Specification

No WSDOT Standard Specification exists; therefore, a special provision must be written.

Additional Information

- Stormwater inlet protection measures should be placed around all catch basins in vicinity of concrete work.
- Performing concrete work in advance of storm events reduces the risk of generating concrete runoff and violating water quality standards.
- BMPs designed for spill prevention and containment can be used to eliminate the risk of discharging concrete runoff to receiving waters.
- Designated areas to hold process water and for tool washing stations will reduce the risk of losing concrete runoff. Dewatering in such areas needs to be done in a way that does not violate water quality standards.

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3.4.10 Check Dams

Definition

Small dams constructed across a swale or drainage ditch. Suitable materials include riprap, washed gravel, sandbags, and prefabricated structures.

Purpose

To reduce the velocity of concentrated flows, reduce erosion of the swale or ditch, and cause some suspended sediment to settle in ponded areas upstream of check dams.

WSDOT Specification

2004 Standard Specifications
8-01.3(6) Check Dams
Check dams shall be installed as soon as construction will allow, or when designated by the Engineer. The Contractor may substitute a different check dam for that specified with approval of the Engineer. Check dams shall be placed in ditches perpendicular to the channel. Check dams shall be of sufficient height to maximize detention, without causing water to leave the ditch.

8-01.3(6)A Geotextile-Encased Check Dam
The geotextile-encased check dam shall meet the requirements in Section 9-14.5(4) Geotextile-Encased Check Dam. Installation of geotextile-encased check dams shall be in accordance with the Plans, and shall be anchored to hold it firmly in place under all conditions.

8-01.3(6)B Rock Check Dam
The rock used to construct rock check dams shall meet the requirements for quarry spalls, in accordance with Section 9-13.6.

8-01.3(6)C Sandbag Check Dam
Sandbags shall be placed so that the initial row makes tight contact with the ditch line for the length of the dam. Subsequent rows shall be staggered so the center of the bag is placed over the space between bags on the previous lift.

8-01.3(6)D Wattle Check Dam
Wattle used to construct wattle check dams shall meet the requirements for 8-01.3(10).

Additional Information

- Whatever material is used, the dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the dam rather than falling directly onto the ditch bottom.
- The material used to fill sand bags should not contribute to turbid runoff. For example, use washed rock or pea gravel.
- Keep the center of the check dam lower than the outer edges at natural ground elevation to prevent flooding of roads, dikes, or other structures.
- Placing rock, geotextile, or erosion control blankets will reduce/eliminate scouring.
- Know the expected flow rates to determine the appropriate check dam material.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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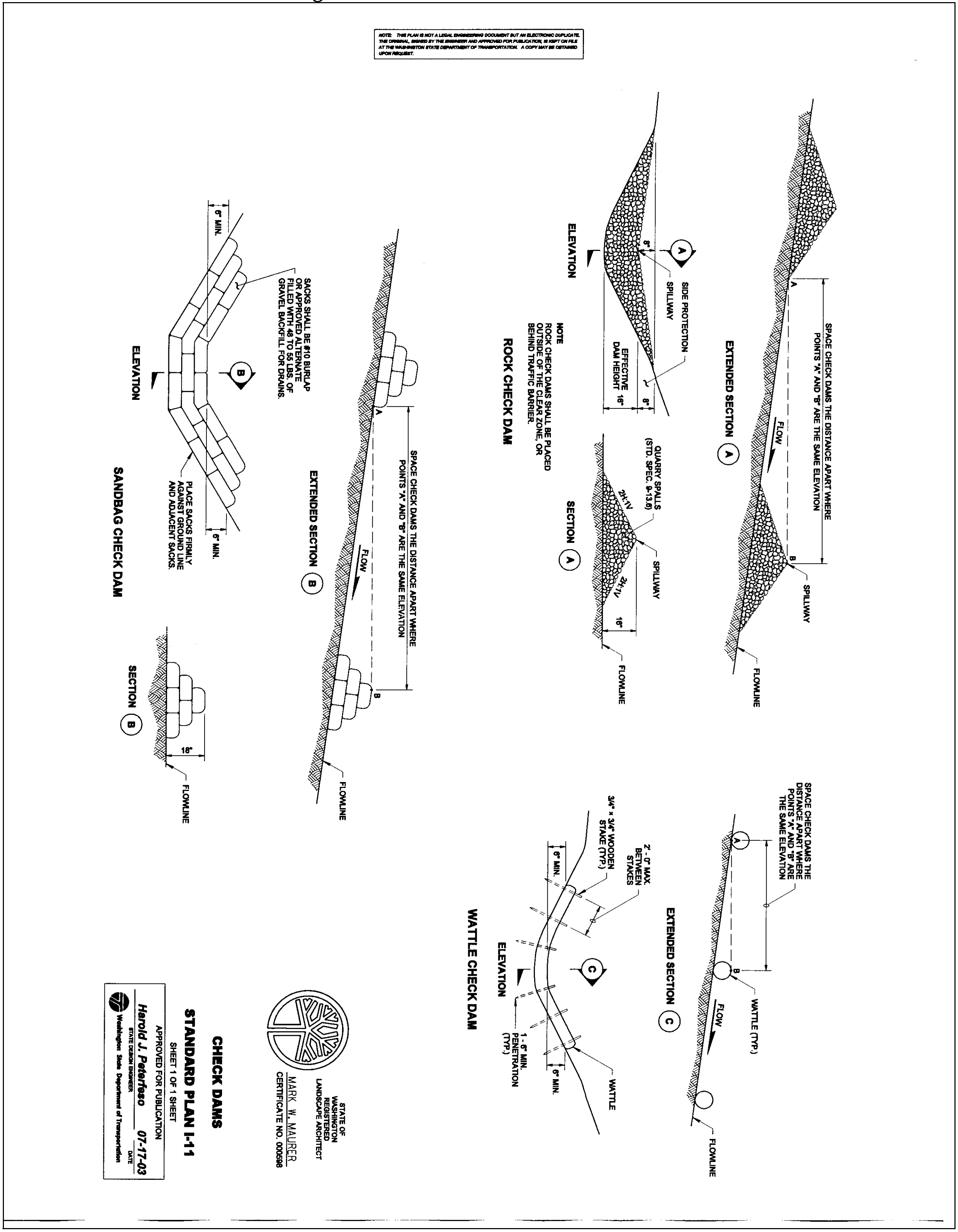
Figure 3.4.10   Check Dams



3.4.11 Triangular Silt Dike (Geotextile-Encased Check Dam)

Definition

A pre-fabricated check dam consisting of a urethane foam core encased in geotextile material.

Purpose

To reduce the velocity of concentrated flows, reduce erosion of the swale or ditch, and cause some suspended sediment to settle in ponded areas upstream of check dams. A triangular silt dike can be mobilized and placed quickly. If they are taken care of, triangular silt dikes can be reused.

WSDOT Specification

2004 Standard Specifications
8-01.3(6) Check Dams
Check dams shall be installed as soon as construction will allow, or when designated by the Engineer. The Contractor may substitute a different check dam for that specified with approval of the Engineer. Check dams shall be placed in ditches perpendicular to the channel. Check dams shall be of sufficient height to maximize detention, without causing water to leave the ditch.

8-01.3(6)A Geotextile-Encased Check Dam
The geotextile-encased check dam shall meet the requirements in Section 9-14.5(4) Geotextile-Encased Check Dam. Installation of geotextile-encased check dams shall be in accordance with the Plans, and shall be anchored to hold it firmly in place under all conditions.

Additional Information

The flexibility of the materials in triangular silt dikes allows them to conform to all channel configurations.

- Can be fastened to soil with staples or rock and pavement with adhesives.
- TSDs have been used to build temporary sediment ponds, diversion ditches, concrete wash out facilities, curbing, water bars, level spreaders, and berms.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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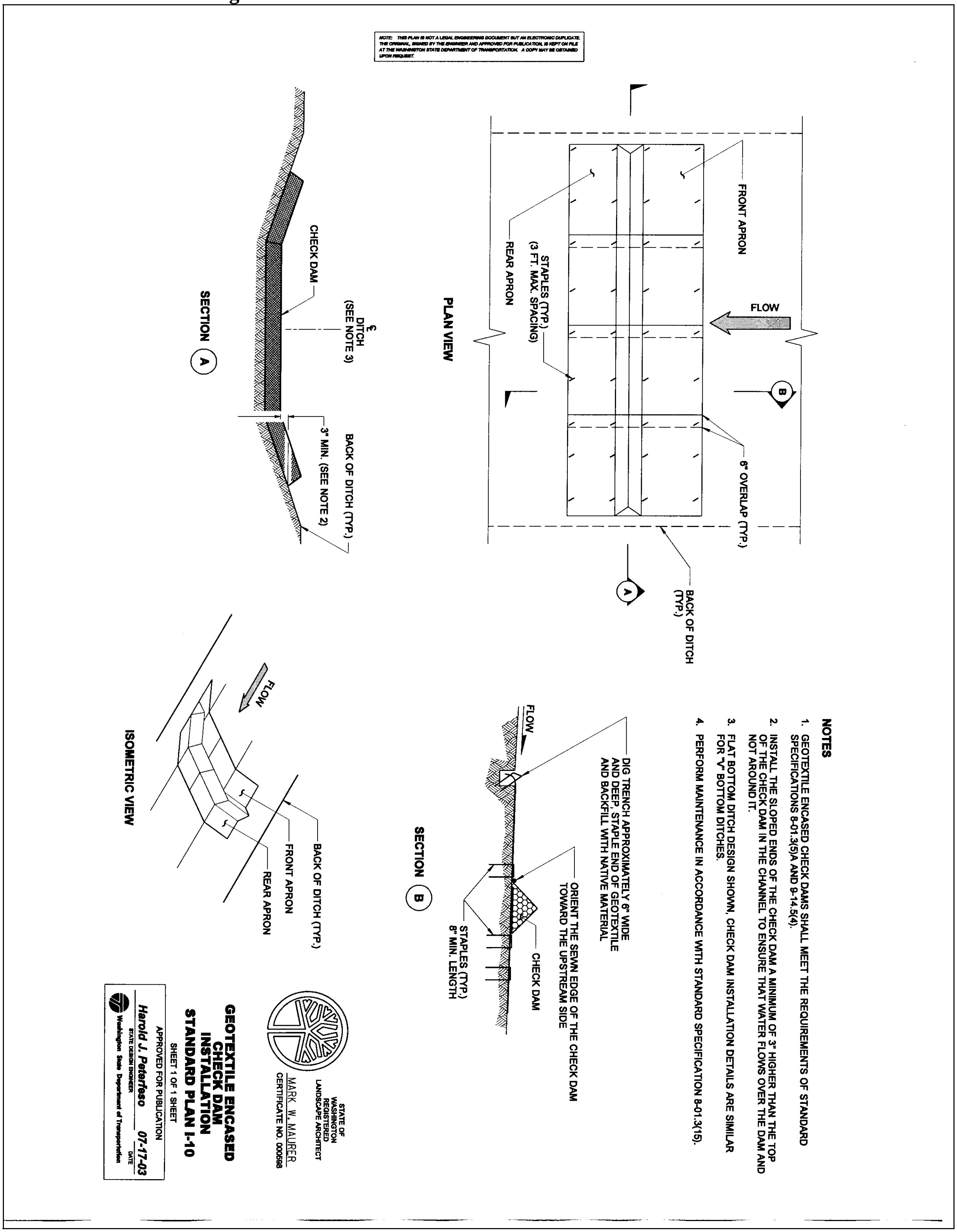
Figure 3.4.11 Geotextile Encased Check Dam



3.4.12 Outlet Protection

Definition

A protective barrier of rock, erosion control blankets, vegetation, or sod constructed at a conveyance outlet.

Purpose

To prevent scour at conveyance outlets and minimize the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

WSDOT Specification

No WSDOT Standard Specification exists; therefore, a special provision must be written.

Additional Information

- Common locations for outlet protection include ponds, pipes, ditches, or other conveyances.
- Size the scale of the outlet protection based on expected flow volumes and velocities.
- Refer to section 3.2.6 of this manual and/or the WSDOT *Highway Runoff Manual* for guidance in choosing appropriate sized rock outlet protection or alternative materials.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.4.

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WSDOT Standard Specification for Maintenance

2004 Standard Specification

8-01.3(15) Maintenance

Erosion control devices shall be maintained so they properly perform their function until the Engineer determines they are no longer needed. The devices shall be inspected on the schedule outlined in Section 8-01.3(1)B for damage and sediment deposits. Damage to or undercutting of the device shall be repaired immediately.

3.5 Sediment Retention

3.5.1 Street Sweeping

Definition

The physical brushing or vacuuming of sediment from the roadway.

Purpose

To prevent sediment tracked onto roadways from entering runoff or the air.

WSDOT Specification

2004 Standard Specifications
8-01.3(8) Street Cleaning
Self-propelled pickup street sweepers shall be used, whenever required by the Engineer, to prevent the transport of sediment and other debris off the project site. Street washing with water will require approval by the Engineer.

Additional Information

- Roadway cleanliness is also a public safety issue.

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3.5.2 Stormwater Dispersal / Infiltration

Definition

The process of disposing of water by allowing dispersal to an area of undisturbed natural vegetation (vegetated strip).

Purpose

To reduce the volume of runoff and the transport of sediment from a construction site.

WSDOT Specification

No WSDOT Standard Specification exists; therefore, a special provision must be written.

Additional Information

- Approval and infiltration site designation from the WSDOT Project Engineer is required before dispersing or infiltrating water.
- Infiltration can be maximized by spreading water over the largest possible area, discharging water at a slow and constant rate, and using vegetated areas whenever possible.
- If an area becomes saturated, give it a break and try it again later.
- Many local jurisdictions require that vegetated strips be identified and protected with signs and fencing.
- Vegetated strips are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond.
- Ideally, vegetated strips shall consist of undisturbed native growth with a well-developed soil that allows for infiltration of runoff.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.3, 3.4 and 3.5.

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3.5.3 Wattles

Definition

Temporary erosion and sediment control barriers consisting of any plant material that is wrapped in biodegradable tubular plastic or similar encasing material. Wattles are typically 8 to 10 inches in diameter and 25 to 30 feet in length.

Purpose

There are two main purposes for wattles: 1) reduce slope length; and 2) trap sediment. Cutting a slope length in half reduces erosion potential by a factor of four. In addition, they also trap sediment whether used on a slope or as a perimeter control device.

WSDOT Specification

2004 Standard Specifications
8-01.3(10) Wattles
Wattles shall be installed as soon as construction will allow or when designated by the Engineer Trench construction and wattle installation shall begin from the base of the slope and work uphill. Excavated material shall be spread evenly along the uphill slope and compacted using hand tamping or other method approved by the Engineer. On gradually sloped or clay-type soils trenches shall be 2 to 3 inches deep. On loose soils, in high rainfall areas, or on steep slopes, trenches shall be 3 to 5 inches deep, or half the thickness of the wattle.

Additional Information

- Wattles can also be used as temporary curbs for conveying water to catch basins and pipe slope drain inlets.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.5.

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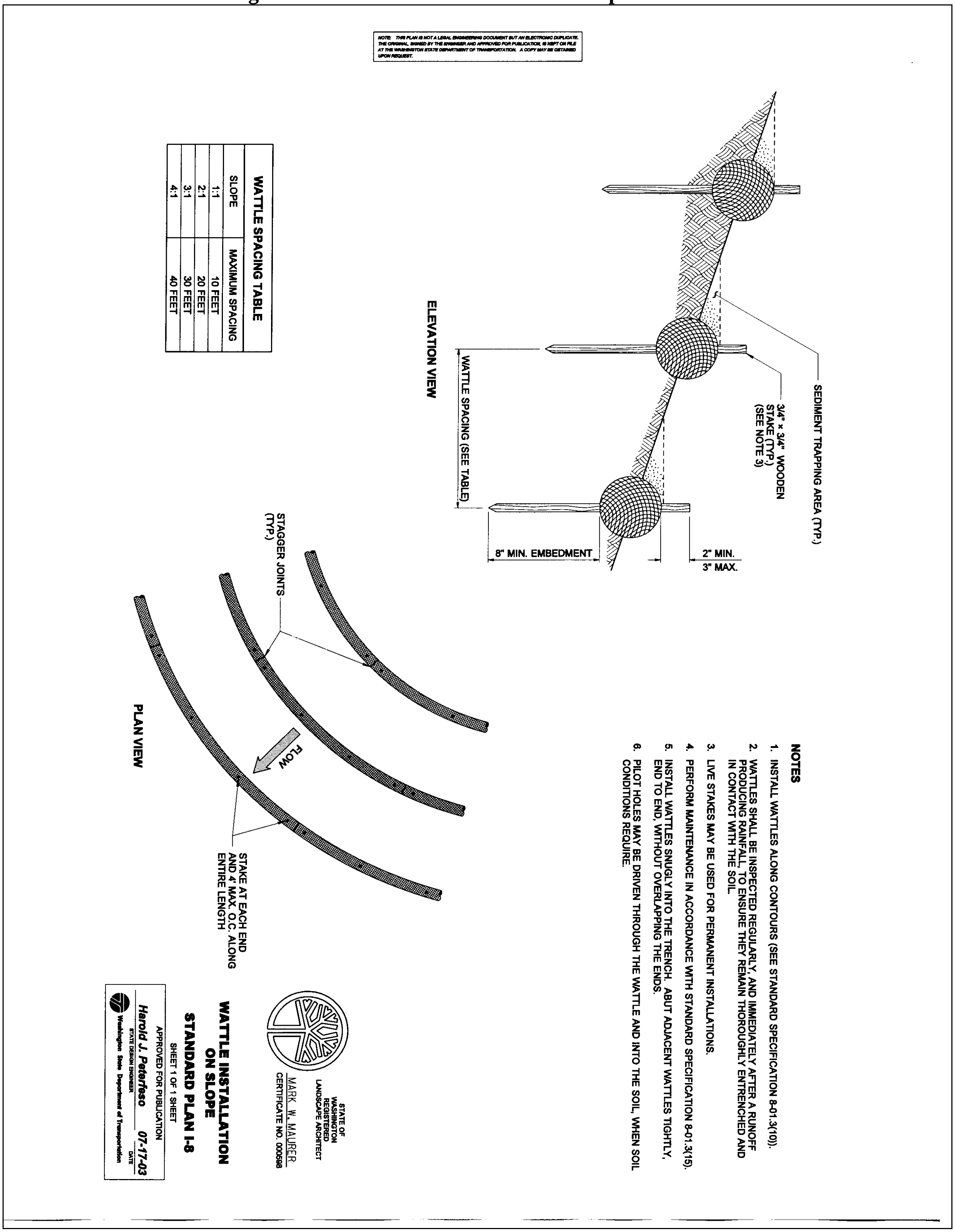
Figure 3.5.3 Wattle Installation On Slope



3.5.4 Silt Fence

Definition

A temporary sediment barrier consisting of a geotextile fabric stretched across and attached to supporting posts, which are entrenched. Adding rigid wire fence backing can strengthen silt fence.

Purpose

To reduce the transport of sediment from a construction site by providing a temporary barrier to sediment and reducing the runoff velocities of sheet flow.

WSDOT Specification

2004 Standard Specifications
8-01.3(9)A Silt Fence
Silt fence shall be constructed in accordance with the Plans. When backup support is used, steel wire shall have a maximum mesh spacing of 2 inches by 4 inches, and the plastic mesh shall be as resistant to ultraviolet radiation as the geotextile it supports. The geotextile shall be attached to the posts and support system using staples, wire, or in accordance with the manufacturer's recommendations. The geotextile shall be sewn together at the point of manufacture, or at a location approved by the Engineer, to form geotextile lengths as required. All sewn seams and overlaps shall be located at a support post. Posts shall be either wood or steel. Wood posts shall have minimum dimensions of 1 1/4 inches by 1 1/4 inches by the minimum length shown in the Plans. Steel posts shall consist of U, T, L, or C shape posts with a minimum weight of 1.33 lbs/ft, or other steel posts having equivalent strength and bending resistance to the posts listed. When sediment deposits reach approximately one-third the height of the silt fence, the deposits shall be removed.

Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.5.

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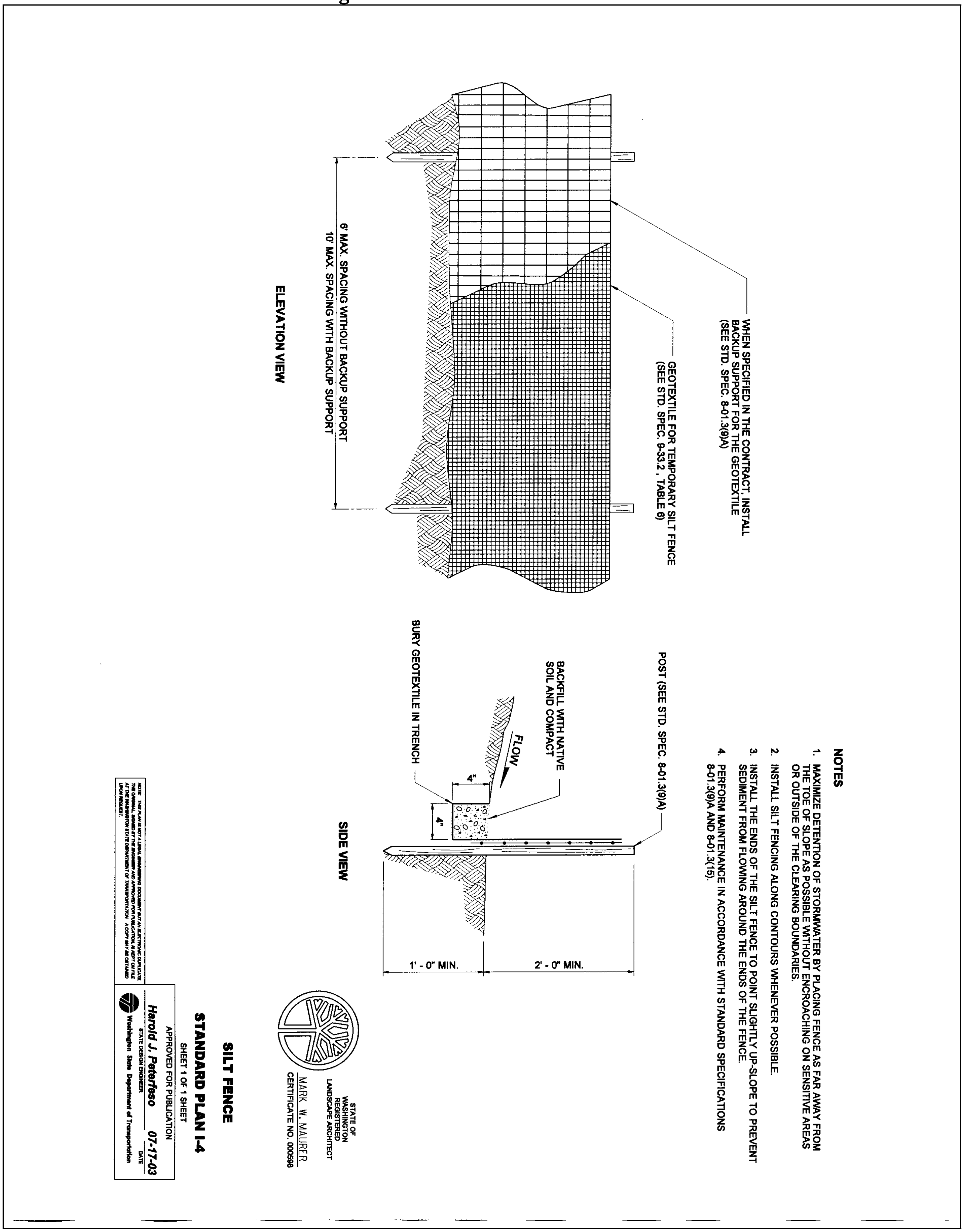
Figure 3.5.4 Silt Fence



3.5.5 Straw Bale Barrier

Definition

A temporary sediment barrier consisting of a row of entrenched and anchored straw bales.

Purpose

To intercept sheet flow and detain small amounts of sediment from disturbed areas.

WSDOT Specification

2004 Standard Specifications
8-01.3(9)C Straw Bale Barrier
Straw shall conform to Section 9-14.4(1).

Additional Information

- Place below disturbed areas subject to sheet and rill erosion.
- They are more suitable for low gradient slopes and small drainage areas.
- The longevity of the barrier is dependent on the time of year and climate.
- Under no circumstances should straw bale barriers be constructed in streams, channels, or ditches.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.5.

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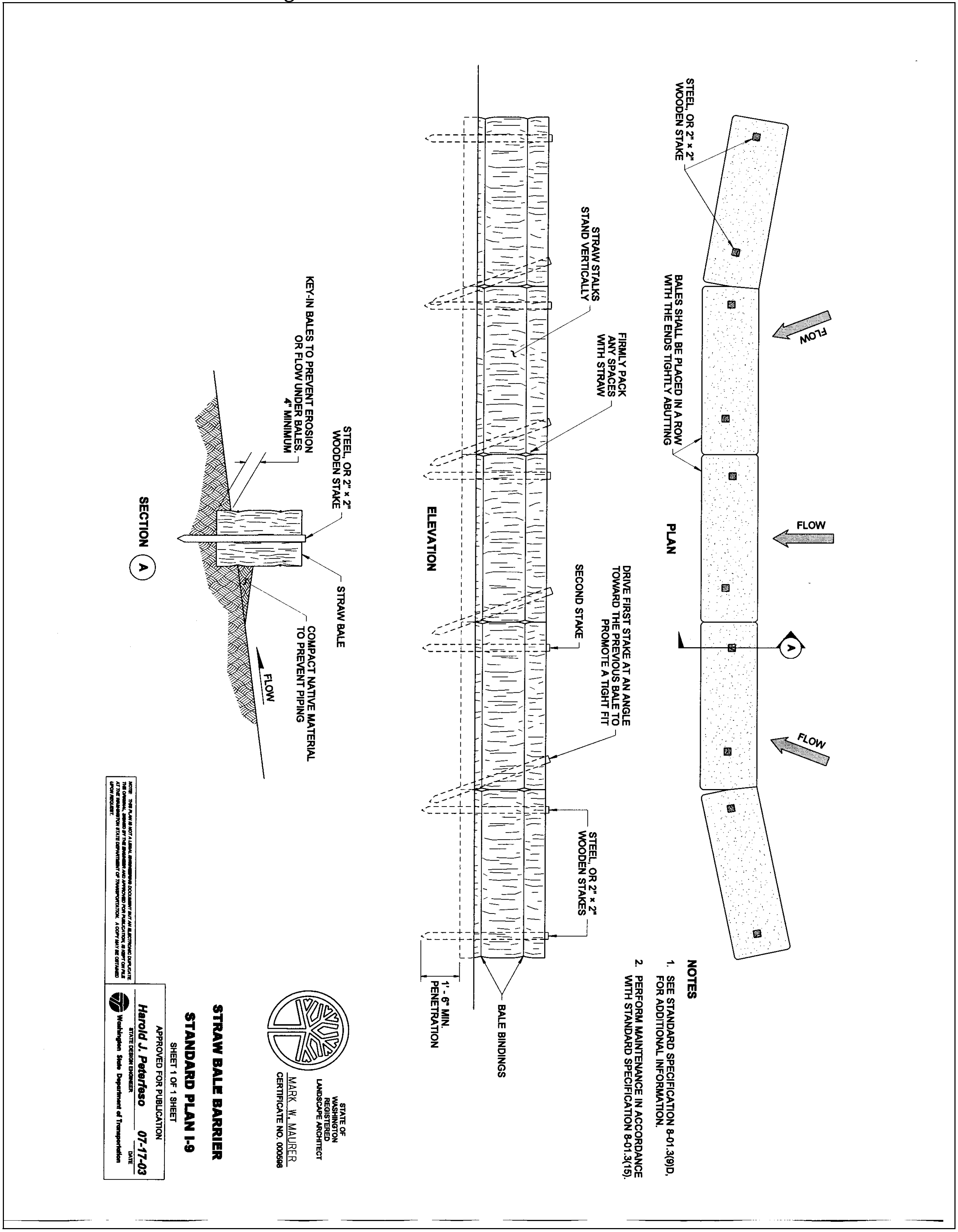
Figure 3.5.5 Straw Bale Barrier



3.5.6 Filter Berm (Gravel/Wood Chip/Compost)

Definition

A berm consisting of gravel, wood chips, or compost.

Purpose

There are two main functions of filter berms. The first is to prevent concentrated flows from damaging exposed cut/fill slopes. The second is to provide perimeter containment of sediment at the toe of a slope.

WSDOT Specification

2004 Standard Specifications
8-01.3(9)B Gravel Filter, Wood Chip or Compost Berm
The gravel filter berm shall be a minimum of one foot in height and shall be maintained at this height for the entire time they are in use. The wood chip berm shall be a minimum of two feet in height and shall be maintained at this height for the entire time they are in use. Wood chips shall meet the requirements in Section 9-14.4(3). Compost shall be Type 2 in accordance with Section 9-14.4(8).

Additional Information

- Pipe slope drains may be needed to convey water that accumulates along the filter berm to prevent blowouts.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.5.

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Figure 3.5.6A   Compost Berm Design At Culvert Ends

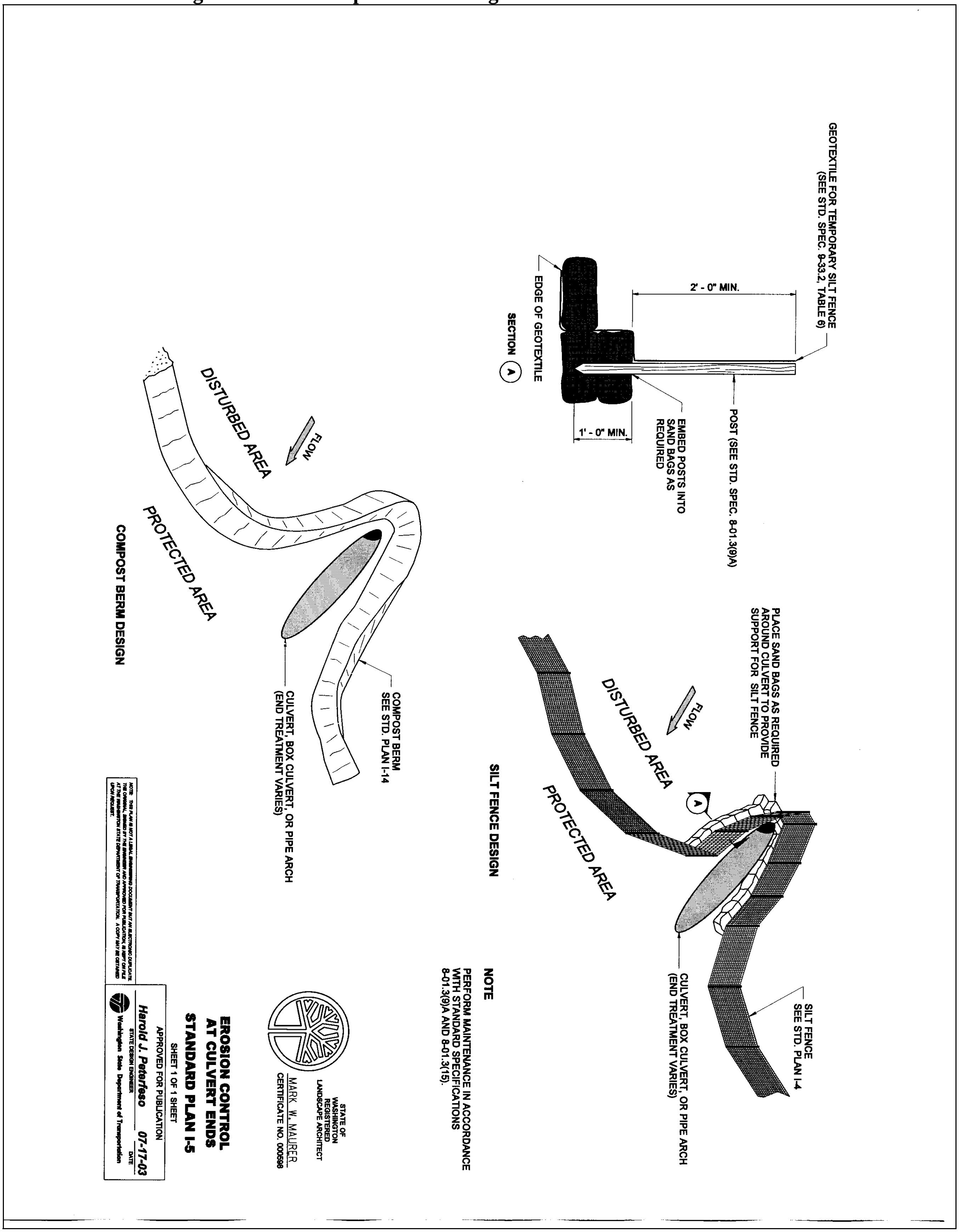
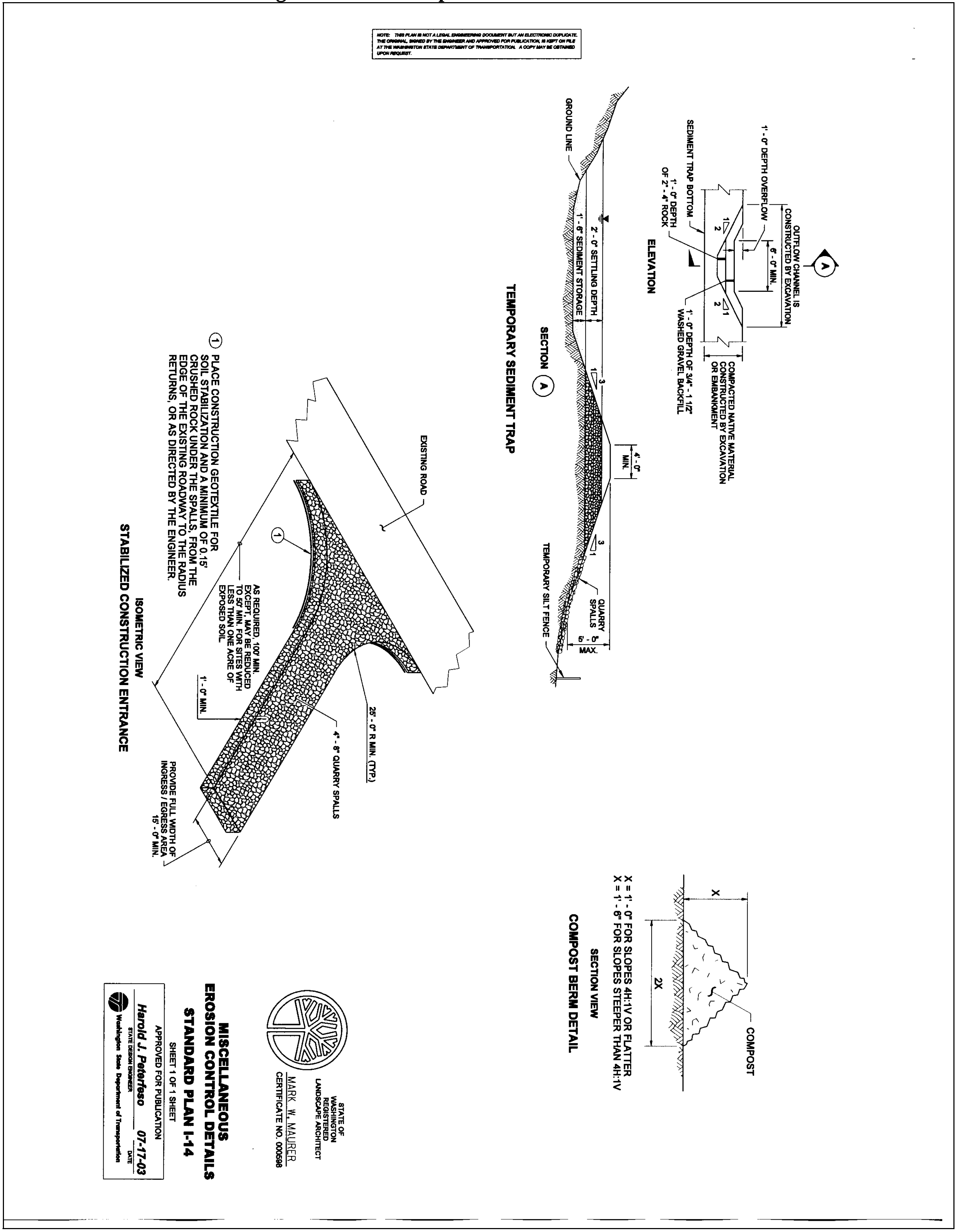


Figure 3.5.6B Compost Berm Detail



3.5.7 Storm Drain Inlet Protection

Definition

Storm drain inlet protection is a concept where sediment is trapped internally or externally of the catch basin. Prefabricated devices are available for both situations.

Purpose

Inlet protection is often the last opportunity to minimize sediment impact to an receiving water body.

WSDOT Specification

2004 Standard Specifications
8-01.3(9)D Inlet Protection
Inlet protection can be performed below and above the inlet grate, or as a cover. All devices shall be installed prior to clearing, grubbing or earthwork activities and shall be as shown in the Plans. Geotextile fabric in all prefabricated inlet protection devices shall meet or exceed the requirements of Table 1 for Moderate Survivability, and the minimum filtration properties of Table 2, in Section 9-33.2. When the depth of accumulated sediment and debris reaches approximately one-half the height of an internal device or one-third the height of the external device (or less when so specified by the manufacturers), the deposits shall be removed and stabilized on site.

8-01.3(9)E Below Inlet Grate
These devices shall be prefabricated units specifically designed for inlet protection and shall remain securely attached to the drainage structure when fully loaded with sediment and debris, or at the maximum level of sediment and debris specified by the manufacturer.

8-01.3(9)F Above Inlet Grate
These devices may be silt fence or prefabricated units specifically designed for inlet protection having the following features: The device shall remain securely in place around the drainage structure under all conditions.

8-01.3(9)G Inlet Grate Cover
These devices shall be prefabricated units specifically designed for inlet protection and have the following features:

1. Be a sewn geotextile fabric unit fitted to the individual grate and completely enclosing the grate.
2. Have built-in lifting devices to allow manual access of the stormwater system.
3. Utilize an orange monofilament geotextile fabric.

Check dams or functionally equivalent devices may be used as inlet protection devices with the approval of the Engineer.

Additional Information

- There is a difference in how internal and external inlet protection devices function.
- Internal devices tend to consist of a non-woven material that is semi-porous. Larger sediments are trapped, but silt and clay sized particles pass through. They are most appropriate in situations where roadway flooding is a concern or construction traffic will damage an external device.
- External devices may be prefabricated or assembled in the field using silt fence. Both trap sediment by creating a ponding area surrounding the inlet. The reduced velocities allow sediment to settle. This process allows external devices to be more efficient at trapping greater volumes of sediment of smaller size.
- The above mentioned inlet protection devices are preferred, however in an emergency, berms of sand bags or washed gravel can be placed around the inlet.

- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.5.

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Figure 3.5.7A Temporary Silt Fence For Inlet Protection In Unpaved Areas

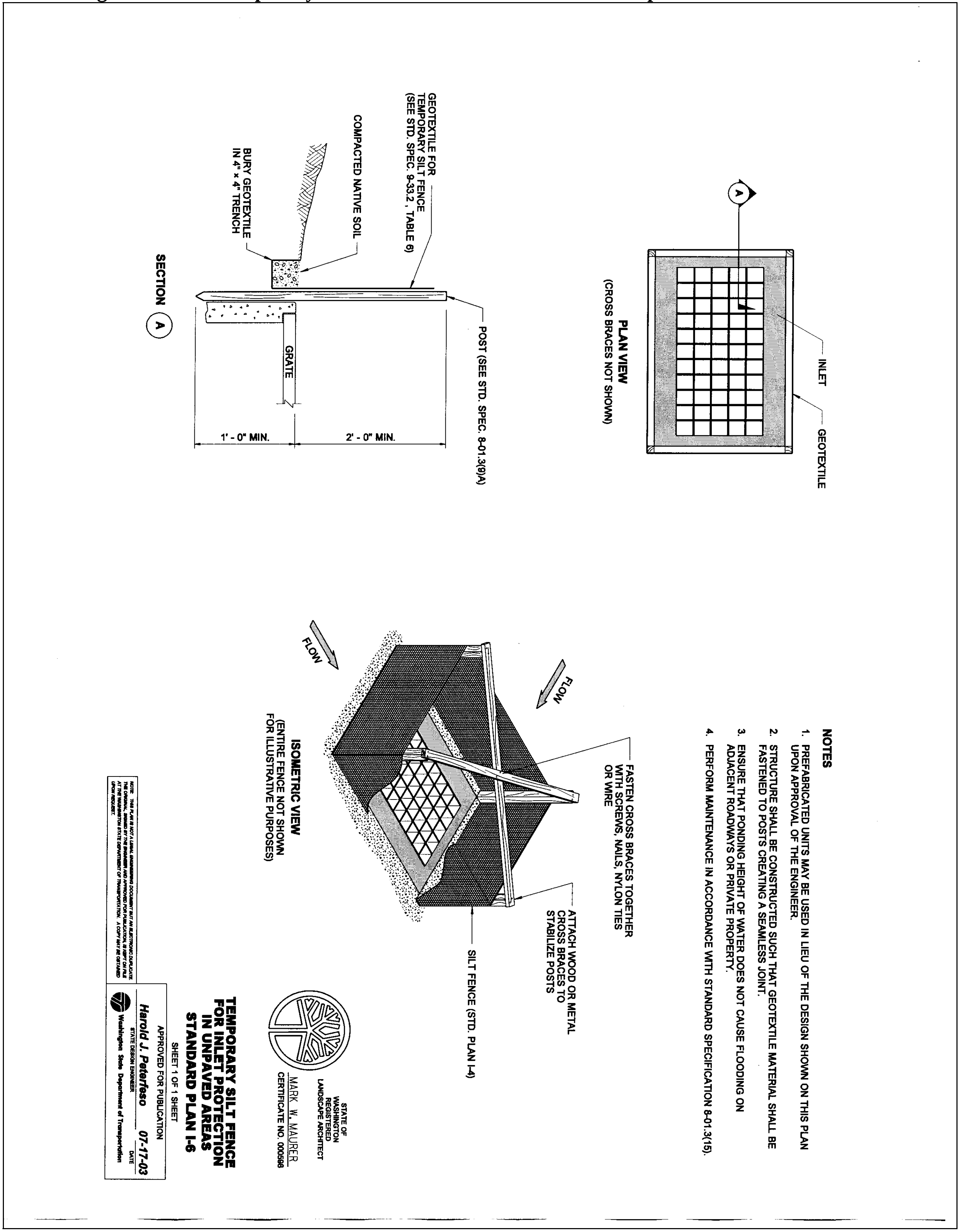
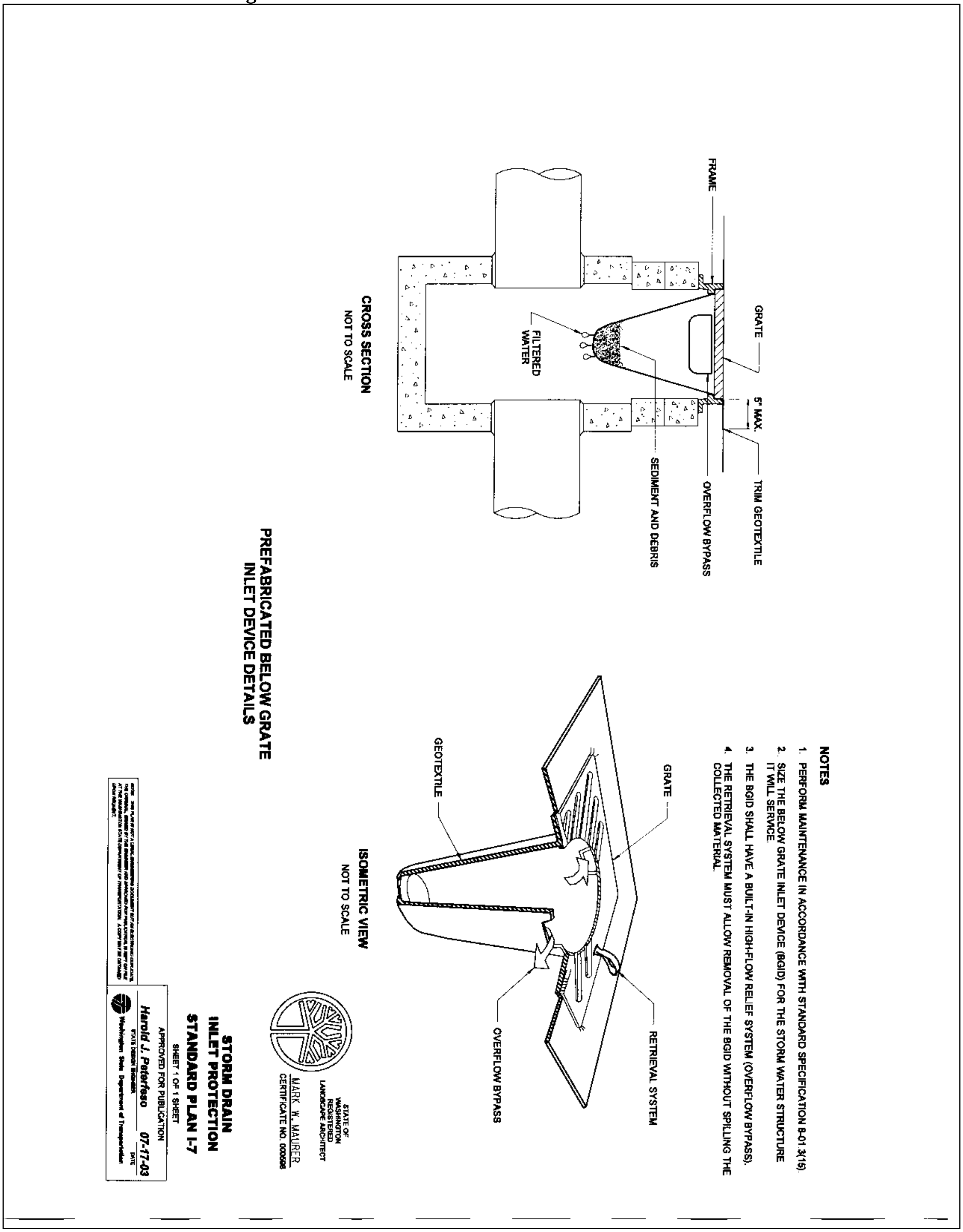


Figure 3.5.7B Storm Drain Inlet Protection



3.5.8 Sediment Trap

Definition

A temporary area using natural depressions or excavated ponds to trap sediment.

Purpose

To collect sediment from concentrated flows and encourage runoff infiltration.

WSDOT Specification

No WSDOT Standard Specification exists; therefore, a special provision must be written.

Additional Information

- Trap efficiency is enhanced when runoff is passed through additional sediment control BMPs.
- Sediment traps do not have to be an engineered structure, however, prior to implementing this BMP, consult with the WSDOT inspector or engineer.
- Sediment traps and ponds are limited to removing medium sized sediment.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.5.

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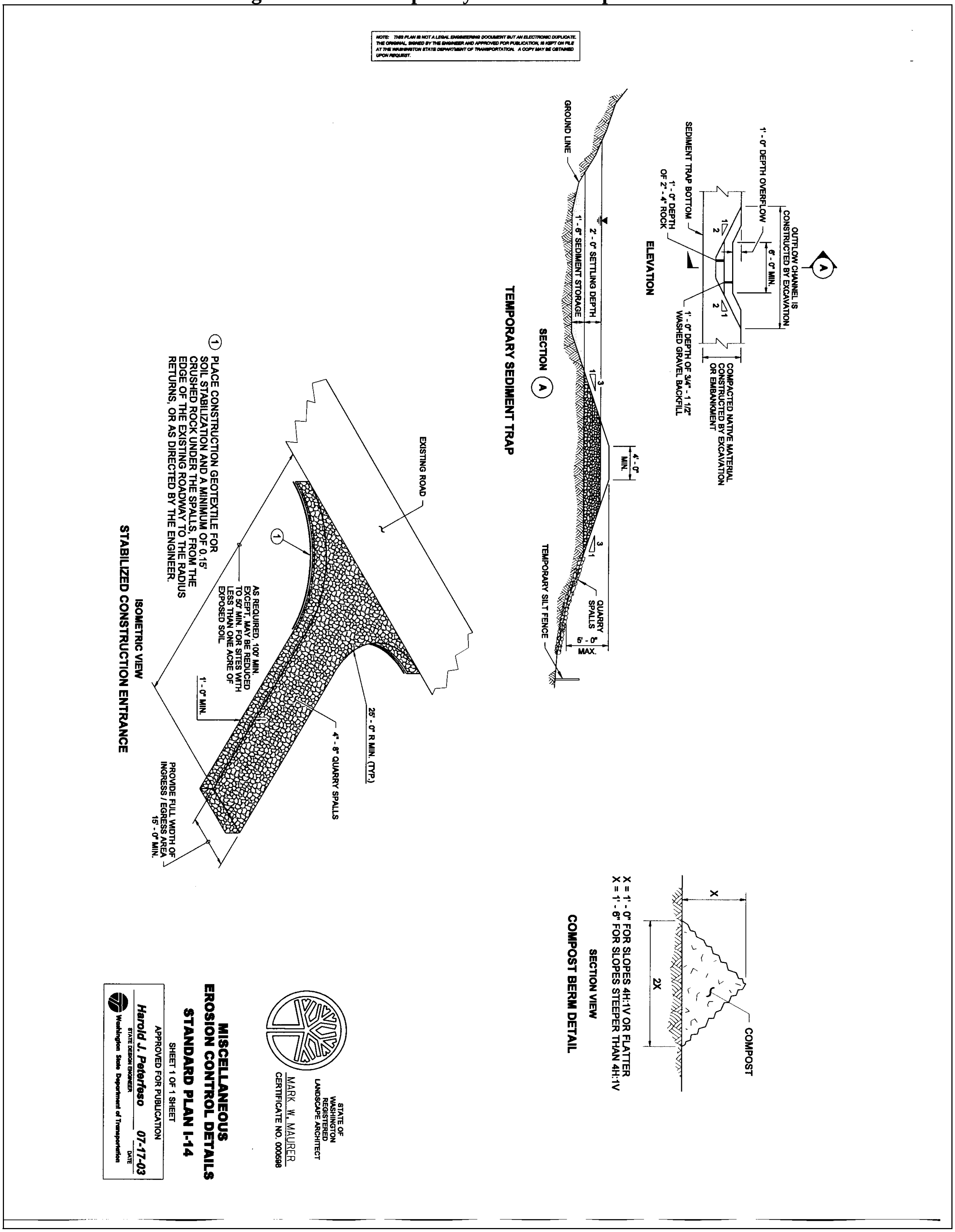
Figure 3.5.8 Temporary Sediment Trap



3.5.9 Temporary Sediment Pond

Definition

A temporary basin with a controlled stormwater release structure.

Purpose

To collect stormwater runoff and detain it long enough to trap sediment and allow infiltration.

WSDOT Specification

2004 Standard Specifications
8-01.3(1)D Detention/Retention Pond Construction
When a detention or retention pond is required, whether it is temporary or permanent, it shall retain/detain the full final design volume of stormwater before beginning other grading and excavation work in the area that drains into that pond. Temporary conveyances shall be installed concurrently with grading in accordance with the TESC plan so that newly graded areas drain to the pond as they are exposed.

Additional Information

- Use of infiltration facilities for sedimentation basins during construction may clog the soils and reduce their capacity to infiltrate.
- If the sediment pond is at final grade a pretreatment structure will minimize the clogging affects of the fine sediments.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.5.

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3.5.10 Construction Stormwater Chemical Treatment

Definition The use of a chemical to encourage flocculation of fine sediments within construction site runoff.

Purpose To reduce the turbidity of stormwater runoff. The addition of flocculants improves a detention ponds ability to remove the fine sediments it otherwise could not by gravity alone.

WSDOT Specification

No WSDOT Standard Specification exists; therefore, a special provision must be written.

Additional Information

- This process is sometimes used in conjunction with stormwater filtration (refer to 3.4.11).

- Due to the small size, shape, and weight of fine particles, such as silt and clay, conventional methods are largely ineffective at removing these particles from construction site runoff.
- Deterrents to the wide spread usage of chemical stormwater treatment include:
    1. It is not cheap.
    2. A special permit is required from the Washington State Department of Ecology.
    3. Adjustment to the treated water pH may be necessary.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.5.

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3.5.11 Construction Stormwater Filtration

Definition

The use of filters to remove sediment from construction site stormwater. The process of pumping construction stormwater through a series of filters, primarily sand. Many of these systems are mobile and can be setup on any construction site.

Purpose

To remove sediment from construction site stormwater ponds.

WSDOT Specification

No WSDOT Standard Specification exists; therefore, a special provision must be written.
Additional Information

- Unlike chemical treatment, the use of construction stormwater filtration does not require approval from Ecology.
- Two types of filtration systems may be applied to construction stormwater treatment: rapid and slow. Rapid sand filters are the typical system used for water and wastewater treatment. They can achieve relatively high hydraulic flow rates, on the order of 2 to 20 gpm/sf, because they have automatic backwash systems to remove accumulated solids. In contrast, slow sand filters have very low hydraulic rates, on the order of 0.02 gpm/sf, because they do not have backwash systems. To date, slow sand filtration has generally been used to treat stormwater. Slow sand filtration is mechanically simple in comparison to rapid sand filtration but requires a much larger filter area.
- **Filtration Equipment.** Sand media filters are available with automatic backwashing features that can filter to 50 µm particle size. Screen or bag filters can filter down to 5 µm. Fiber wound filters can remove particles down to 0.5 µm. Filters should be sequenced from the largest to the smallest pore opening.

Sediment removal efficiency will be related to particle size distribution in the stormwater.

- **Treatment Process Description.** Stormwater is collected at interception point(s) on the site and is diverted to a sediment pond or tank for removal of large sediment and storage of the stormwater before it is treated by the filtration system. The stormwater is pumped from the trap, pond, or tank through the filtration system in a rapid sand filtration system. Slow sand filtration systems are designed as flow through systems using gravity.
- If large volumes of concrete are being poured, pH adjustment may be necessary.
- Filtration may also be used in conjunction with polymer treatment in a portable system to assure capture of the flocculated solids.
- Maintenance – Refer to WSDOT Standard Specification for Maintenance at the end of section 3.5.

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WSDOT Standard Specification for Maintenance

2004 Standard Specifications

8-01.3(15) Maintenance

Erosion control devices shall be maintained so they properly perform their function until the Engineer determines they are no longer needed. The devices shall be inspected on the schedule outlined in Section 8-01.3(1)B for damage and sediment deposits. Damage to or undercutting of the device shall be repaired immediately.

Section 4

4.1 Standard Specification for SPCC Plan

2004 Standard Specifications Page 1-61

1-07.15(1) Spill Prevention, Control and Countermeasures Plan

The Contractor shall prepare a project specific spill prevention, control and countermeasures (SPCC) plan to be used for the duration of the project. The plan shall be submitted to the Engineer prior to the commencement of any on site construction activities. The Contractor shall maintain a copy of the plan at the work site, including any necessary updates as the work progresses. If hazardous materials are encountered during construction, the Contractor shall do everything possible to control and contain the material until appropriate measures can be taken. Hazardous material, as referred to within this specification, is defined in RCW 70.105.010 under “Hazardous Substances”. Occupational safety and health requirements that pertain to SPCC planning are contained in WAC 296-155 and WAC 296-62.

The SPCC plan shall address the following project-specific information:

1. SPCC Plan Elements

A. Site Information
Identify general site information useful in construction planning, recognizing potential sources of spills, and identifying personnel responsible for managing and implementing the plan.

B. Project Site Description
Identify staging, storage, maintenance, and refueling areas and their relationship to drainage pathways, waterways, and other sensitive areas.
Specifically address:
- the Contractor’s equipment maintenance, refueling, and cleaning activities.
- the Contractor’s on site storage areas for hazardous materials.

C. Spill Prevention and Containment
Identify spill prevention and containment methods to be used at each of the locations identified in B., above.

D. Spill Response
Outline spill response procedures including assessment of the hazard, securing spill response and personal protective equipment, containing and eliminating the spill source, and mitigation, removal and disposal of the material.

E. Standby, On-Site, Material and Equipment
The plan shall identify the equipment and materials the Contractor will maintain on site to carry out the preventive and responsive measures for the items listed.

F. Reporting
The plan shall list all federal, state and local agency telephone numbers the Contractor must notify in the event of a spill.

G. Program Management
Identify site security measures, inspection procedures and personnel training procedures as they relate to spill prevention, containment, response, management and cleanup.

H. Preexisting Contamination
If preexisting contamination in the project area is described elsewhere in the plans or specifications, the SPCC plan shall indicate measures the Contractor will take to conduct work without allowing release or further spreading of the materials.

2. Attachments

A. Site plan showing the locations identified in (1. B. and 1. C.) noted previously.

B. Spill and Incident Report Forms, if any, that the Contractor will be using.

Implementation Requirements
The Contractor shall be prepared and shall carry out the SPCC plan in the event of a hazardous spill within the project limits.

Payment
The lump sum contract price for the “SPCC Plan” shall be full pay for:

1. All costs associated with creating the SPCC plan.

2. All costs associated with providing and maintaining on site standby materials and equipment described in the SPCC plan. As to other costs associated with spills the contractor may request payment as provided for in the Contract. No payment shall be made if the spill was caused by or resulted from the Contractor’s operations, negligence or omissions.

Section 5

Glossary

Best Management Practice (BMP): The structural devices, maintenance procedures, managerial practices, prohibitions of practices, and schedules of activities that are used singly or in combination to prevent or reduce the detrimental impacts of stormwater, such as pollution of water, degradation of channels, damage to structures, and flooding.

Clean Water Act (CWA): Water pollution is regulated under the Federal Water Pollution Control Act of 1972, known as the Clean Water Act. The CWA established effluent discharge limitations and receiving water quality standards under United States EPA. Enforcement of the CWA has been delegated to Ecology.

Ecology: Washington State Department of Ecology

Environmental Compliance Assurance Procedures (ECAP): The purpose of the Environmental Compliance Assurance procedure is to recognize and eliminate environmental violations during the construction phase on Washington State Department of Transportation (WSDOT) construction sites, and to ensure prompt notification to WSDOT management and agencies. For purposes of this procedure, violations are defined as actions that are not in compliance with environmental standards, permits, or laws.

Environmental Management System (EMS): Ensures efficiency and allows accountability to be demonstrated to resource agencies and the public. It relies heavily on compliance assurance activities in its continuous evolution of effectiveness. The two primary activities used are the annual fall assessment and standardized water quality monitoring protocols.

Endangered Species Act (ESA): The Endangered Species Act of 1973, as amended, was adopted to prevent the extinction of animals and plants. The ESA protects endangered species by prohibiting "the take of listed species without special permit" where take means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect or the intent to engage in such activities." Harm also includes indirect harm to listed species by harming the habitat.

Environmental Protection Agency (EPA): Regulatory agency responsible for implementing and enforcing the CWA.

Erosion Control Program (ECP): Applies the standards of an Environmental Management System to proactively plan, implement, and monitor Temporary Erosion and Sediment Control (TESC) activities. The ECP maintains effectiveness through regular review and update of existing erosion control policies, procedures, guidance documents, and training curriculum. Changes are based on solid data gathered by a number of compliance assurance activities.

Erosion and Sediment Control Lead (ESC Lead): Erosion and Sediment Control (ESC) Leads are required on all WSDOT projects involving earthwork. The qualifications and responsibilities of the ESC Lead are described in section 8-01.3(1)B of the *Standard Specifications*.

Fall Assessment: Routine performance evaluation of construction projects to verify the effectiveness of erosion control measures. Data collected from the Fall Assessment is used to evaluate BMP effectiveness by year and determine trends.

Gray Notebook: A quarterly WSDOT publication that reports the status of projects and program performance.

Highway Runoff Manual (HRM): The HRM is the guidance document used by WSDOT, engineering consultants, and many local transportation agencies for designing stormwater control systems as part of transportation improvement projects. Conformance to the provisions of the manual result in consistent design procedures statewide, and support the acceptance of WSDOT stormwater planning by regulatory agencies.

Instructional Letter: An internal WSDOT document that provides rules and procedures for varying topics.

Mixing Zone: A mixing zone is defined in state law as "that portion of a water body adjacent to an effluent outfall where mixing results in the dilution of the effluent with the receiving water. Water quality criteria may be exceeded in a mixing zone as conditioned and provided for in WAC 173-201A-100." The use, size, and location of mixing zones are established in permits or orders by the Department of Ecology.

Nephelometric Turbidity Units (NTU): Units of turbidty measurement. Calculated from the amount of light that is deflected by the suspended material in a water sample.

National Pollution Discharge Elimination System (NPDES): The part of the federal Clean Water Act that requires point source dischargers to obtain permits, called NPDES permits, which in Washington State are administered by the Department of Ecology.

Spill Prevention Control and Countermeasures Plan (SPCC): All WSDOT projects require the contractor to prepare a SPCC plan. It describes the BMPs that will be employed to prevent the contamination of a site from all forms of pollution other than sediment.

Standard Specifications/Plans: WSDOT's guidance material that provides default contract language for all WSDOT projects and illustrated details of BMP installation.

Temporary Erosion and Sediment Control Plan: WSDOT prepares an initial erosion control plan for all projects involving soil disturbances. These plans are prepared in advance to satisfy permit requirements for project approval. The TESC plan establishes when, where, and how specific BMPs will be implemented to prevent erosion and the transport of sediments from a site during construction. *Manual*. Contractors are encouraged to modify the TESC plan so that it is compatible with their construction plans. Implementation of the plan and maintenance of BMPs is the responsibility of the ESC Lead.

Temporary Erosion and Sediment Control (TESC) Elements: All TESC plans must address the 12 elements described in Section 2.3 of this document and in the *Highway Runoff*.   When creating a TESC Plan, each TESC element should be evaluated for risk and explained in as much detail as necessary. The evaluation must include all stages of project construction and account for varying seasons.

WSDOT: Washington State Department of Transportation